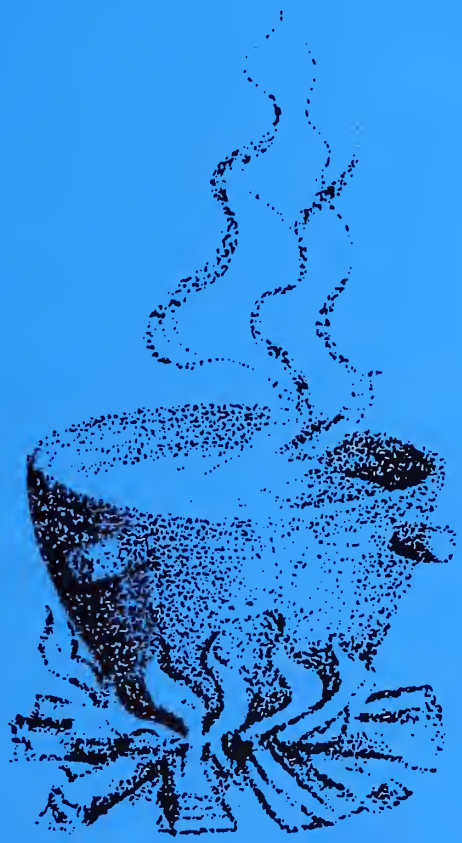
SUGARCANE RESEARCH

Annual Progress Report

1994



Louisiana State University
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SUGARCANE RESEARCH

ANNUAL PROGRESS REPORT

1994

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LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER
H. ROUSE CAFFEY, CHANCELLOR

LOUISIANA AGRICULTURAL EXPERIMENT STATION
KENNETH W. TIPTON
VICE CHANCELLOR AND DIRECTOR

The Louisiana Agricultural Experiment Station provides equal opportunities in programs and employment.

FOREWORD

Research on sugarcane in the Louisiana Agricultural Experiment Station is an integral part of the LSU Agricultural Center's research-extension effort to provide the knowledge and technology base for efficient production and processing of sugarcane. Sugarcane research projects are led by scientists in the Sugar Station/Audubon Sugar Institute, and the departments of Agricultural Economics and Agribusiness, Agronomy, Biological and Agricultural Engineering, Entomology, and Plant Pathology and Crop Physiology.

Members of the Louisiana Agricultural Experiment Station maintain close working relations with colleagues in respective departments of the College of Agriculture and other colleges of the LSU Baton Rouge campus, the Louisiana Cooperative Extension Service, the Agricultural Research Service and Soil Conservation Service of the USDA, the American Sugar Cane League, and the Louisiana Department of Agriculture and Forestry.

A major portion of the resources for production and processing research are linked to the St. Gabriel Station and Sugar Station/Audubon Sugar Institute respectively. The Iberia Research Station helped to accomplish specific sugarcane research objectives in 1994.

Important parts of the 1994 research effort were conducted on cooperating farms and in cooperating factories throughout the industry. The dwindling of the farm labor supply has been making the evaluation of location effects and location interaction effects increasingly difficult. However, these evaluations are very important and must be continued. **The cooperation of individual farms and sugarcane factories in conducting research projects and financial support of the American Sugar Cane League is gratefully acknowledged.**

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Louisiana Agricultural Experiment Station
Louisiana State University Agricultural Center
Baton Rouge, Louisiana 70803
and

United States Department of Agriculture
Agricultural Research Service
Washington, D.C. 20250
and

American Sugarcane League of the U.S.A., Inc.
Thibodaux, Louisiana 70301

Notice of Release of Sugarcane Variety LCP 86-454

The Louisiana Agricultural Experiment Station of the Louisiana State University Agricultural Center, the Agricultural Research Service of the United States Department of Agriculture and the American Sugar Cane League of the U.S.A., Inc., working cooperatively to improve sugarcane varieties, have jointly developed and hereby announce the release of a new variety, **LCP 86-454**, for commercial planting in the fall of 1994.

LCP 86-454 was selected from progeny of the cross CP 77-310 X CP 69-380. Results from 89 replicated trials over 7 years and 19 test locations indicate that the yield of sugar and cane per acre of LCP 86-454 are comparable to CP 65-357, CP 70-321 and CP 74-383. The variety produces low stalk populations. The stalk number per acre is less than that of CP 70-321 in plant cane and similar in stubble crops. The stalks of LCP 86-454 are larger in diameter and greater in weight than those of the check varieties in all crops. The recoverable sugar content of the variety is similar to CP 65-357 and has a milling factor of 1.035 and a cane fiber content of 12.6%. The variety is suited to mechanical harvesting, with harvesting characteristics similar to CP 72-370 and CP 74-383.

LCP 86-454 is resistant to injury caused by the sugarcane borer, *Diatraea saccharalis* (F.), is resistant to smut (*Utilago scitaminea* Syd. & P. Syd.), moderately resistant to leaf scald (*Xanthomonas albilineans*), susceptible to the sugarcane mosaic virus and susceptible to ratoon stunting disease (*Clavibacter xyli* subsp. *xyli*). Preliminary data suggest that the variety is tolerant to herbicides used in sugarcane production.

Seed cane will be distributed by the American Sugar Cane League in accordance with procedures to be announced to all sugarcane growers in Louisiana on or after June 29, 1994. Inquires concerning seed cane should be directed to the American Sugar Cane League, 206 E. Bayou Rd., Thibodaux, LA 70301. The Louisiana Agricultural Experiment Station and the United States Department of Agriculture do not have seed cane available for distribution.

Each agency will make such news releases as considered appropriate.

K. W. Tyston — 5/10/94
Director, Louisiana Agricultural Experiment Station — Date

Howard J. Brad — JUN 02 1994
Administrator, Agricultural Research Service — Date

Norman B. Boyt — 5-16-94
Chairman of the Board — Date
American Sugar Cane League of the U.S.A., Inc.

AN OVERVIEW OF THE LOUISIANA "L" SUGARCANE VARIETY DEVELOPMENT PROGRAM

F. A. Martin
Sugar Station/Audubon Sugar Institute

The primary objective of the Louisiana Sugarcane Variety Development Program is contribute to the profitability of the Louisiana sugarcane industry by breeding and developing improved sugarcane varieties.

Sugarcane breeding and variety development in the LAES is carried out by a team of scientists working under several CRIS projects. Although each member of the LAES Sugarcane Variety Development Team has a specific area of responsibility, each team member also has a general understanding of the entire program and often is called upon to assist in other areas of the program. Current team members (Table 1.) contribute expertise in the areas of agronomy, breeding, genetics, statistics, entomology, pathology, weed science, and physiology.

Table 1. Members of the LAES Sugarcane Breeding and Variety Development Team.

Team Member	Budgetary Unit	Responsibility
F. A. Martin	Agronomy/Sugar Station/ASI	Program Leader
K. B. Bischoff	Agronomy	Selection
S. B. Milligan	Agronomy	Methodology/Genetics
H. P. Schexnayder, Jr.	St. Gabriel Station	Photoperiod & Crossing
P. H. Rodriguez	Agronomy	Variety Testing
G. L. Hawkins	Sugar Station/ASI	Sucrose Lab
H. P. Schexnayder	St. Gabriel Station	Farm Manager
H. P. Viator	Iberia Station	Variety Testing
K. L. Quebedeaux	Iberia Station	Variety Testing
T. E. Reagan	Entomology	Insect Resistance
J. W. Hoy	Plant Pathology & Crop Physiology	Disease Resistance Testing
J. L. Griffin	Plant Pathology & Crop Physiology	Herbicide Tolerance

The LAES sugarcane breeding team and the USDA sugarcane breeding team work independently yet cooperatively to produce "L" and "HoCP" varieties, respectively. The best varieties from the two programs are brought together for evaluation at the "outfield test locations." Outfield testing is conducted by personnel of the Louisiana Agricultural Experiment Station, the United States Department of Agriculture, and the American Sugar Cane League in accordance to the provisions of the "Three-way agreement of 1978." After yield data for one crop cycle (plant cane, first stubble, and second stubble) is collected in the outfield, those varieties that show promise are released for commercial production.

The most significant event for the Louisiana Sugarcane Variety Development Program in 1994 was the release of LCP 86-454 for commercial production. We trust that the variety LCP 86-454 will contribute to the well being of the Louisiana sugarcane industry. There are three points associated with the release of the variety that merit comment. The first point is that release of a variety is the highest achievement in the discipline of plant breeding. LCP 86-454 is the fourth variety release in five years that was selected by LAES sugarcane breeders. The second point is that the LAES team and the USDA team cooperate to achieve more than either can achieve independently. The crosses that produced this variety and the three other recent releases, LCP 82-89, LHo 83-153, and LCP 85-384, were produced by USDA breeders. The final point is achievements in plant breeding were built on foundations laid by those who came before us. The parents of these varieties were commercial CP varieties and varieties that were developed through the USDA Basic breeding program. Likewise, today's achievements are the foundation for tomorrow's progress. Progress in the "L" Sugarcane Breeding and Variety Development Program would not be possible without the support of the Director of the Louisiana Agricultural Experiment Station and the financial support of the American Sugar Cane League.

Photoperiod treatments were begun in early June. Besides the normal 12-hour 30-minute treatments, two special experiments were conducted in 1994. One experiment was to compare a 12-hour 15-minute inductive treatment with the standard inductive treatment. The second experiment was to determine the effect of cool mist (above a temperature threshold) on flower induction. Variety by treatment effects were found in both experiments.

We produced 329 crosses with 616 tassels of 72 sugarcane varieties. We produced over 500,000 viable seed, with over 450,000 from 247 biparental crosses. The high germination (mean of 214 seed per gram of fuzz for biparental crosses) may have resulted from warm temperatures during the crossing season and/or the replenishment of male tassels to crosses after the initial setup. The practice of adding male tassels to cubicles after the initial setup was begun as a result of Dr. Adel Abousalama's research (Ph.D., LSU, 1990).

Of the 66,892 seedlings established in the field in 1994, 50,554 were scheduled for selection in 1995. A cross appraisal test analyzed by Mr. Ronny Zaunbrecher (M.S. student of Dr. Milligan) was used to select families of the 1992 crossing series prior to single plant selection. From 106 crosses available for selection, 56 crosses were selected for single plant selection. Initially 5033, or 21.3%, of the single plants from the selected families were selected. Of these, 2988 or 59.4% had sufficient brix (by hand refractometer) and were planted in the first-line trials.

Established procedures were used to advance clones from first-line trials to second-line trials and from second-line trials to increase-trials. After preliminary ratings for cane yield and plant type in August, clones with acceptable ratings are further evaluated for lodging, borer damage, presence of disease, presence of pith/tube, and brix/sucrose content. The numbers of plots established included 842 second-line and 288

increase. Forty five (45) selections of the 1989 crossing series were assigned permanent "L" numbers and planted in replicated plots at multiple locations.

Leaf scald was observed in some second-line trial plots at the St. Gabriel Station during the fall of 1994. It is expected that this disease will add extra pressure on the LAES sugarcane breeding program. The exchange of "L" and "HoCP" varieties was curtailed when leaf scald was discovered at Chacahoula in 1992. We expect to resume the exchange of recently assigned varieties in 1995.

The distribution of "L" clones through stages of testing in 1994 is presented in Table 2. The practice of placing nursery trials (planted in years 5 & 6) at multiple locations allows us to more efficiently identify the superior varieties in each assignment series.

Table 2. Number of "L" clones by Series at most advanced stage of testing for the series in 1994.

Series	Stage of Testing	Year from seedling	Number of clones
L 1986	Release	13	1
L 1987	Outfield - Second Stubble	12	0
L 1988	Outfield - First Stubble	11	0
L 1989	Outfield - Plant Cane	10	1
L 1990	Outfield - Planted in outfield	9	0
L 1991	Outfield - Planted in outfield	8	2
L 1992	Outfield - Introduced	7	9
L 1993	Nursery - Plant Cane	6	31
L 1994	Assignment	5	45

More detailed information on each stage of the Louisiana Sugarcane Variety Development Program follows.

1994 PHOTOPERIOD AND CROSSING IN THE LOUISIANA "L" SUGARCANE VARIETY DEVELOPMENT PROGRAM

H.P. Schexnayder, Jr., S. B. Milligan, and F. A. Martin
St. Gabriel Research Station, Agronomy Department, and Sugar Station

The production of sufficient quantities of viable seed from the most desirable crosses is the objective of the photoperiod and crossing stage of the Louisiana "L" Sugarcane Variety Development Program. The success of the subsequent stages of the program is dependent upon success at this stage.

Usual procedures were followed in starting cuttings of potential parent varieties in the fall of 1993. Cuttings were transferred to can culture in the greenhouse in January 1994. The cans were moved to the photoperiod rail carts in April, and the first photoperiod treatments were begun on May 30.

Natural lighting and six light-tight chambers (photoperiod bays) were used to impose photoperiod treatments. To prevent overwhelming crossing facilities, two major flowering peaks separated by two weeks were planned (Table 1). Clonal flowering and pollen production data were used to place clones on specific bays and carts. Specifically, the Days from the start of photoperiod treatment To the appearance of the First Flower (DTFF) within a treatment were used. The range of estimated DTFF was usually limited to 10d per cart. Easier to induce varieties on a cart, falling outside the 10d range, may have been removed prior to the start date and reinstalled later to tighten the predicted flowering range within the 10d span. More difficult to flower clones or those clones with no flowering history were generally placed within the late peak and the hardest to induce flowering treatments (bays 5 & 6). Clones scheduled for use as males were placed in center bays 3 and 4. Easier to flower clones were more often placed in bays 1 through 3 with a few cans of these varieties in bays 4 through 6 which housed the harder to induce varieties. Material on photoperiod bay 2 was targeted to flower slightly earlier because a large number of female varieties were placed in this bay (Table 1). Within a bay, the hardest to induce clones were placed on cart C because this is this first cart that can be rolled into the bay, and hence photo-treatments can be started on varieties on this cart without starting treatments on varieties on carts B and A. Modifications of photoperiod procedures in 1994 included placing the cans in galvanized metal trays, which helped moderate moisture status in the cans.

All photoperiod treatments began with consecutive days of 12½-h photoperiod, with the exception of Bay 5, Cart C, which had 12¼-h photoperiod (Table 1). During July the reduction of day length by 1 min d^{-1} or ½ min d^{-1} was begun. Treatments differed by the number of days with constant day length and the date on which the decline of photoperiod was initiated. All photoperiod treatments were discontinued on September 10, 1994 when natural daylength and decline approximated the artificially induced photoperiod treatment. Besides the normal

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This project was partially funded by the American Sugar Cane League.

photoperiod treatments, two experiments were conducted. One experiment addressed the effects of cool mist (triggered by a temperature threshold) on flower induction of certain hard to induce varieties. The second experiment compared the effect of a shorter initial constant photoperiod on flowering.

Synchronization of tasseling between the two peaks and across all six bays was good with the average flower date for both peaks falling very near the targeted dates (tables 1 and 2). Some experimental varieties that had undergone treatment were not used in crossing because they were dropped from the testing program. Nine varieties of recent assignment series (1992 & 1993) and three older hard to induce varieties (CP82-551, HoCP89-885, and LCP 86-422) did not flower in 1994.

The Paradox Pal computer program that facilitates crossing decisions was further enlarged to use more parental and cross performance information and to store flowering information which previously required reentry. Crossing began on September 12 and ended on November 8, 1994. Six hundred-sixteen tassels of 72 varieties were used to produce 329 crosses (tables 3 & 4). Over 500,000 viable seed, with over 450,000 from 247 biparental crosses, were produced. The high germination (mean of 214 seed per gram of fuzz for biparental crosses) may have resulted from warm temperatures during the crossing season and/or the replenishment of male tassels to crosses after the initial setup. The practice of adding male tassels to cubicles after the initial setup was begun as a result of Dr. Adel Abousalama's research (Ph.D., LSU, 1990).

The carts in the crossing greenhouse (rails 7 & 8) were use to make the first approximation of the photoperiod response of new varieties by comparing the date of tasseling of new varieties with those of known varieties. Natural flowering began on November 15, and observations were conducted through January 9, 1995. At that time, all varieties that had not tasseled were examined for signs of induction. Results from rails 7 & 8 are found in tables 5 and 6. No crosses were made with the tassels from cans on rails 7 and 8.

Data of the crosses and seed produced sorted by cross number, female parent, and male parent are presented in tables 7 through 9, respectively.

Table 1. Summary of 1994 photoperiod treatments§.

Bay	Cart	Earliest Start Treatment	Mean Days of Constant Photoperiod£	Decline		Mean Days of Decline	Target Flower Date	Actual Mean Flower Date
				Date Began	Rate (min d^{-1})			
1	A	June 9	32 ± 8	July 15	1	77 ± 13	Sept. 29	Sept. 30 ± 13
1	B	June 1	44 ± 0	July 15	1	78 ± 12	Sept. 29	Oct. 1 ± 12
1	C	June 1	44 ± 0	July 15	1	77 ± 14	Sept. 29	Sept. 30 ± 14
2	A	June 12	29 ± 0	July 11	1	74 ± 12	Sept. 25	Sept. 23 ± 12
2	B	June 7	34 ± 1	July 11	1	76 ± 12	Sept. 25	Sept. 25 ± 12
2	C	June 7	24 ± 9	July 11	1	83 ± 10	Sept. 25	Oct. 2 ± 10
3	A	June 21	21 ± 6	July 15	1	79 ± 11	Sept. 29	Oct. 2 ± 11
3	B	June 11	28 ± 9	July 15	1	75 ± 9	Sept. 29	Sept. 28 ± 9
3	C	June 1	44 ± 0	July 15	1	76 ± 9	Sept. 29	Sept.29 ± 9
4	A	June 7	33 ± 7	July 12	½	94 ± 8	Oct. 9	Oct.14 ± 8
4	B	June 7	34 ± 5	July 12	½	93 ± 11	Oct. 9	Oct. 13 ± 11
4	C	May 30	41 ± 8	July 12	½	91 ± 11	Oct. 9	Oct.11 ± 11
5	A	June 18	30 ± 6	July 22	1	74 ± 8	Oct. 9	Oct. 4 ± 8
5	B	June 18	33 ± 4	July 22	1	80 ± 13	Oct. 9	Oct. 10 ± 13
5	C	June 18	32 ± 5	July 22	1	70 ± 5	Oct. 9	Sept. 30 ± 5
6	A	May 30	53 ± 0	July 22	1	83 ± 11	Oct. 9	Oct. 13 ± 11
6	B	May 30	51 ± 6	July 22	1	85 ± 9	Oct. 9	Oct. 15 ± 9
6	C	May 30	50 ± 8	July 22	1	80 ± 12	Oct. 9	Oct. 10 ± 12

§ All Bays were heated with exception of Bay 1 which received no heat.

£ The constant photoperiod treatment was 12.½h for all bays except for Bay 5, Cart C which was treated with a constant photoperiod of 12.¼h.

Table 2. Varietal flowering summary by 1994 photoperiod treatment.

Variety	Peak	Decline Rate§	Days to First Flower£	Mean Days to Flower	Mean Pollen Rating¥	Total stalks	Percent flowered
		Min d^{-1}	----- Days -----		-----No.-----		%
CP65-357	Early	1.0	109	110.5	6.3	8	100
CP65-357	Late	1.0	107	107.0	9.0	5	80
CP70-321	Late	0.5	122	123.5	3.0	7	29
CP70-321	Late	1.0	126	141.4	3.8	14	71
CP70-330	Early	1.0	109	121.8	6.0	10	50
CP70-330	Late	1.0	110	127.2	7.0	10	60
CP72-370	Early	1.0	99	110.6	4.7	31	42
CP72-370	Late	0.5	120	130.9	3.8	17	65
CP72-370	Late	1.0	107	112.5	4.3	16	31
CP76-301	Late	1.0	165	165.0	5.0	7	14
CP76-331	Early	1.0	86	92.5	2.3	14	57
CP76-331	Late	0.5	96	96.0	4.0	4	50
CP76-331	Late	1.0	91	98.6	3.0	12	50

Table 2. continued.

Variety	Peak	Decline Rate§	Days to First Flower£	Mean Days to Flower	Mean Pollen Rating¥	Total stalks	Percent flowered
CP77-310	Early	1.0	85	97.0	4.3	9	44
CP77-310	Late	0.5	135	135.0	3.0	4	25
CP77-405	Early	1.0	92	100.2	5.4	6	100
CP77-407	Early	1.0	92	97.0	1.7	7	43
CP77-407	Late	0.5	110	110.0	7.0	2	100
CP78-317	Early	1.0	102	117.8	3.7	9	67
CP78-317	Late	0.5	112	114.5	3.0	2	100
CP79-318	Early	1.0	99	107.1	6.4	11	82
CP79-318	Late	1.0	98	107.0	7.8	12	100
CP79-348	Early	1.0	89	92.8	8.8	13	31
CP79-348	Late	1.0	92	109.0	6.0	13	31
CP80-323	Early	1.0	108	114.0	3.3	11	36
CP80-323	Late	0.5	125	129.8	3.5	7	71
CP82-551	Late	1.0	None†	.	.	8	0
CP83-644	Late	1.0	140	143.5	6.0	13	23
CP84-730	Late	1.0	133	133.0	9.0	8	13
CP84-772	Early	1.0	99	99.0	3.0	2	100
CP84-772	Late	0.5	122	122.0	4.0	3	67
HoCP88-739	Early	1.0	112	114.7	7.7	7	57
HoCP88-739	Late	1.0	116	117.0	9.0	6	33
HoCP88-769	Early	1.0	118	118.0	3.0	3	100
HoCP88-769	Late	1.0	130	130.0	3.0	3	33
HoCP89-846	Early	1.0	105	115.0	6.5	21	95
HoCP89-846	Late	1.0	102	114.0	5.0	15	93
HoCP89-885	Early	1.0	None	.	.	10	0
Ho89-889	Early	1.0	111	126.0	4.8	6	83
Ho89-889	Late	0.5	129	131.0	3.9	12	92
HoCP90-923	Late	1.0	126	130.8	9.0	7	86
HoCP90-941	Early	1.0	97	100.8	3.3	9	89
HoCP90-955	Early	1.0	105	112.6	3.5	7	71
HoCP90-955	Late	1.0	117	119.7	3.0	8	50
HoCP90-957	Late	1.0	137	146.2	3.9	14	71
HoCP90-963	Late	0.5	135	137.5	4.5	6	100
HoCP91-552	Early	1.0	97	101.0	1.0	4	100
HoCP85-845	Early	1.0	126	132.0	5.0	10	40
HoCP85-845	Late	1.0	107	122.0	4.4	33	76
LCP81-010	Early	1.0	89	99.8	7.5	6	67
LCP81-010	Late	1.0	91	97.4	5.4	10	60
LCP81-030	Early	1.0	98	104.5	3.0	5	80
LCP81-030	Late	1.0	109	110.8	3.5	9	56
LCP82-089	Early	1.0	119	126.0	3.0	2	100
LCP82-089	Late	0.5	125	134.1	3.2	16	75
LCP82-089	Late	1.0	106	129.5	2.8	19	84

Table 2. continued.

Variety	Peak	Decline Rate	Days to First Flower	Mean Days to Flower	Mean Pollen Rating	Total stalks	Percent flowered
		Min d^{-1}	----- Days -----		-----No.-----		%
LCP83-137	Late	1.0	135	139.9	6.2	12	83
LCP85-313	Early	1.0	91	98.8	8.6	14	79
LCP85-341	Early	1.0	97	108.7	7.7	4	100
LCP85-341	Late	0.5	110	110.0	4.0	2	50
LCP85-371	Early	1.0	101	103.5	3.0	4	100
LCP85-371	Late	0.5	114	114.0	3.0	2	50
LCP85-384	Early	1.0	97	107.6	2.9	33	52
LCP85-384	Late	0.5	118	125.3	1.9	19	63
LCP85-384	Late	1.0	109	120.5	2.0	11	36
LCP86-422	Early	1.0	Abrt	.	.	8	0
LCP86-422	Late	1.0	None	.	.	3	0
LCP86-429	Early	1.0	96	97.8	9.0	7	100
LCP86-450	Early	1.0	116	121.0	3.8	6	83
LCP86-454	Early	1.0	95	104.0	4.9	14	50
LCP86-454	Late	0.5	122	122.0	4.0	3	33
LCP86-454	Late	1.0	107	107.0	3.0	3	33
LHo83-153	Early	1.0	None	.	.	3	0
LHo83-153	Late	0.5	None	.	.	3	0
LHo83-153	Late	1.0	140	143.0	7.7	10	30
LHo92-307	Early	1.0	94	98.2	1.8	6	83
LHo92-307	Late	0.5	118	118.0	1.0	2	50
LHo92-314	Early	1.0	113	122.7	3.2	8	88
L84-290	Early	1.0	94	95.3	2.3	8	88
L84-290	Late	0.5	117	119.0	3.3	4	100
L85-294	Early	1.0	120	129.3	6.3	4	100
L88-072	Early	1.0	101	103.0	2.8	8	100
L88-072	Late	0.5	123	131.5	3.0	5	60
L89-113	Early	1.0	125	127.0	6.0	9	22
L89-113	Late	0.5	122	125.0	5.4	16	50
L89-113	Late	1.0	104	109.3	6.3	18	39
L89-163	Late	0.5	142	145.3	7.7	4	100
L91-250	Early	1.0	116	117.3	8.3	7	43
L91-255	Early	1.0	90	102.9	2.4	11	73
L91-255	Late	0.5	111	115.2	3.4	6	100
L91-261	Late	0.5	134	142.9	4.0	13	54
L91-281	Early	1.0	96	102.3	6.8	17	94
L91-288	Early	1.0	101	110.0	4.8	10	50
L91-290	Early	1.0	Boot	.	.	5	0
L92-309	Early	1.0	115	119.8	4.5	7	100
L92-310	Early	1.0	126	126.0	3.0	3	67
L92-310	Late	0.5	None	.	.	3	0
L92-311	Early	1.0	None	.	.	4	0

Table 2. continued.

Variety	Peak	Decline Rate	Days to First Flower	Mean Days to Flower	Mean Pollen Rating	Total stalks	Percent flowered
		Min d^{-1}	----- Days -----		-----No.-----		%
L92-312	Early	1.0	119	119.0	3.0	4	50
L92-312	Late	0.5	130	131.5	3.5	2	100
L92-313	Early	1.0	138	143.4	4.2	5	100
L92-319	Early	1.0	117	118.0	2.0	3	67
L92-321	Early	1.0	105	108.5	2.0	2	100
L92-322	Early	1.0	107	107.0	5.0	3	33
L92-323	Early	1.0	112	112.0	1.0	7	14
L92-333	Early	1.0	Boot	.	.	1	0
L92-337	Early	1.0	88	92.8	3.0	9	78
L92-337	Late	0.5	119	119.0	3.0	3	100
L92-349	Early	1.0	128	138.8	7.8	7	71
L92-355	Early	1.0	131	131.0	5.0	5	20
L93-358	Early	1.0	None	.	.	2	0
L93-363	Early	1.0	110	110.0	9.0	2	50
L93-364	Early	1.0	Boot	.	.	1	0
L93-378	Early	1.0	None	.	.	3	0
L93-382	Early	1.0	None	.	.	2	0
L93-393	Early	1.0	124	124.0	1.0	2	100
L93-395	Early	1.0	113	116.0	3.0	3	100
L93-396	Early	1.0	None	.	.	5	0
L93-397	Early	1.0	126	126.0	7.0	2	50
L93-401	Early	1.0	None	.	.	3	0
US77-010	Early	1.0	None	.	.	3	0
US77-010	Late	1.0	98	102.0	2.6	8	63
US77-017	Early	1.0	Indc	.	.	5	0
US77-017	Late	1.0	91	95.5	7.8	12	58
US78-020	Late	0.5	130	131.5	6.0	4	50
US78-020	Late	1.0	133	140.3	4.3	8	100
US79-010	Early	1.0	112	114.3	3.0	6	100
US80-003	Early	1.0	110	117.7	3.2	6	100
US80-004	Early	1.0	102	107.2	5.0	7	100

§ Decline rate is the rate of photoperiod decline after a fixed number of days with a constant photoperiod length.

£ Days to first flower is calculated as the number of days from the initiation of photoperiod treatments until the first flower of a variety-treatment combination.

¥ Pollen rating is visually assigned where 1=much pollen to 9=no pollen.

† Abrt - aborted; Boot - boot stage; Emgd - emerged; Indc - induced; None - no flowering response.

Table 3. Can, variety, and flower information on Bays 1 - 6 subjected to photoperiod treatments.

Varieties used in crossing†	Cans used	Cans with tassels	Total stalks	Total tassels	Mean stalks per can	Mean tassels per can‡	Mean pollen rating§	Mean flowering date
---------- Number ----------								Days
72	315	240	1017	616	3.49 ±1.58	2.93 ±1.61	4.67 ±2.73	Oct. 5 ±13.9

† Note that 84 varieties were kept for crossing but 12 did not flower.
‡ Mean tassels per can were based on only cans that produced a tassel.
§ Pollen abundance is rated 1= high to 9 = none. Generally, < 5 is male, ≥ 5 is female.

Table 4. Summary of 1994 crossing and seed production activities.

Type of Cross	Crosses	Sum of seed production	Mean seed production per cross	Mean seed production per female tassel	Mean germination per gram seed
			---------- Number----------		
Biparental	247	455,701	1845 ±1390	1752 ±1301	214 ±121
Poly	34	70,300	2068 ±1677	1832 ±1196	234 ±102
Self	48	34,993	729 ±855	423 ±678	88 ±87
Total	329	560,989	1705 ±1416	1566 ±1305	198 ±123

Table 5. Can, variety, and flower information on Bays 7 & 8 under natural photoperiod conditions.

Total Cans	Cans Used	Total Varieties		Varieties Flowering		Mean Stalks Per Can	Mean Flowers Per Can
		Known†	Unknown‡	Known	Unknown		
----------Number----------						----Number/Can----	
108	85	4	38	4	30	3.74	1.78

† Flowering ability is known.
‡ Flowering ability is unknown.

Table 6. Summary of varietal responses to natural photoperiod in 1994.

Variety	First Flower Date†	Mean Flower Date†	Mean Pollen Rating§	No. of Tassels
*CP65-357	346	350.0	8.0	4
Ho93-768	Indc‡	.	.	.
Ho93-769	Boot	.	.	.
Ho93-770	319	323.0	3.7	3
Ho93-771	334	336.7	7.7	6
Ho93-772	348	348.0	5.0	1
Ho93-773	350	355.5	4.0	6
Ho93-774	348	348.0	5.0	1
HoCP93-775	335	339.0	5.0	2
HoCP93-776	374	374.0	5.0	1
*L89-113	341	346.7	3.7	4
L93-358	Indc	.	.	.
L93-363	340	340.5	8.0	2
L93-365	357	364.5	3.0	2
L93-366	327	328.5	7.0	6
L93-371	Emgd	.	.	.
L93-372	346	347.0	9.0	5
L93-373	343	346.3	9.0	3
L93-374	346	348.8	4.2	5
L93-376	368	368.0	7.0	1
L93-378	Indc	.	.	.
L93-380	335	336.8	4.0	5
L93-382	None	.	.	.
L93-385	339	340.3	4.6	5
L93-386	339	341.4	3.0	5
L93-387	335	343.3	9.0	6
L93-388	365	368.5	3.0	2
L93-389	334	335.5	6.7	6
L93-390	336	338.5	4.3	6
L93-391	341	346.0	6.3	3
L93-392	360	366.0	6.0	2
L93-393	Boot	.	.	.
L93-394	332	352.8	4.5	4
L93-395	338	340.8	6.0	4
L93-396	338	338.0	5.0	1
L93-397	332	332.0	3.0	1
L93-398	Indc	.	.	.
L93-399	350	350.0	9.0	3
L93-400	351	363.2	3.3	6
L93-401	352	352.0	3.0	1
*LCP85-313	346	346.0	5.0	1
*LCP85-384	332	338.0	2.8	21

† Julian Date.

‡ Abrt - aborted; Boot - boot stage; Emgd - emerged; Indc - induced; None - no flowering response.

§ Pollen rating is visually assigned where 1=much pollen to 9=no pollen.

* Varieties used for reference.

Table 7. Crosses and seed made in 1994 sorted by cross number.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-001	CP79-348	LCP85-371	1156	XL94-054	LCP85-313	L93-395	569
XL94-002	LCP85-371	LCP85-371	320	XL94-055	HoCP89-846	L93-395	907
XL94-003	CP79-348	CP77-405	877	XL94-056	L93-395	L93-395	372
XL94-004	CP77-405	CP77-405	1940	XL94-057	US80-004	CP76-331	2262
XL94-005	HoCP90-955	LHo92-307	191	XL94-058	LCP85-341	CP76-331	998
XL94-006	CP77-405	LHo92-307	2028	XL94-060	CP76-331	CP76-331	745
XL94-007	LHo92-307	LHo92-307	467	XL94-061	CP79-318	US79-010	2453
XL94-008	CP79-348	HoCP91-552	1226	XL94-062	HoCP89-846	US80-003	135
XL94-009	HoCP91-552	HoCP91-552	3032	XL94-063	CP77-405	L88-072	1922
XL94-010	HoCP90-941	94P1	1612	XL94-064	US80-004	L88-072	1203
XL94-011	L92-321	94P1	1589	XL94-065	LHo92-314	CP77-310	1698
XL94-012	LCP85-371	94P1	1187	XL94-066	HoCP89-846	CP77-310	3126
XL94-013	HoCP90-941	HoCP91-552	2397	XL94-067	CP77-310	CP77-310	1038
XL94-014	L91-281	HoCP91-552	3557	XL94-068	LCP85-313	LCP85-384	1696
XL94-015	LCP86-429	HoCP91-552	3340	XL94-069	US80-004	LCP85-384	2202
XL94-016	L92-322	L91-255	2855	XL94-070	LCP86-454	CP77-310	1860
XL94-017	LCP86-429	L91-255	3717	XL94-071	CP79-318	CP77-310	2494
XL94-018	L91-255	L91-255	529	XL94-072	LCP86-454	US79-010	366
XL94-019	LCP86-429	LHo92-307	308	XL94-073	LCP86-454	US77-010	2845
XL94-020	L91-281	LHo92-307	116	XL94-074	HoCP89-846	US77-010	1527
XL94-021	CP77-405	L91-288	629	XL94-075	CP79-318	US77-010	4700
XL94-022	CP79-348	L91-288	750	XL94-076	US77-010	US77-010	2226
XL94-023	L91-288	L91-288	197	XL94-077	LCP85-313	L91-281	0
XL94-025	CP77-405	L92-337	1455	XL94-078	LCP86-454	L91-281	95
XL94-026	L92-337	L92-337	91	XL94-079	L91-281	L91-281	11
XL94-027	LCP85-341	HoCP90-941	1182	XL94-080	LCP81-030	94P2	626
XL94-028	LCP86-429	HoCP90-941	3938	XL94-081	HoCP90-941	94P2	533
XL94-029	HoCP90-941	HoCP90-941	482	XL94-082	LCP85-313	94P2	153
XL94-030	LCP85-341	L88-072	1159	XL94-083	HoCP89-846	LCP85-384	2681
XL94-031	L88-072	L88-072	282	XL94-084	CP79-318	LCP85-384	4324
XL94-032	L91-281	HoCP90-941	1124	XL94-085	Ho89-889	LCP85-384	7040
XL94-033	L91-288	HoCP90-941	484	XL94-086	HoCP89-846	US79-010	1321
XL94-034	L91-281	L88-072	895	XL94-087	HoCP89-846	L92-319	2589
XL94-035	LCP86-429	L88-072	1296	XL94-088	CP65-357	L92-319	2688
XL94-036	L91-288	L91-255	3178	XL94-089	L92-319	L92-319	319
XL94-037	LCP81-010	L91-255	1411	XL94-090	LCP85-313	LHo92-314	1583
XL94-038	L93-363	CP84-772	873	XL94-091	LHo92-314	LHo92-314	428
XL94-039	LCP86-429	CP84-772	1085	XL94-092	US80-003	94P3	1378
XL94-040	CP84-772	CP84-772	793	XL94-093	US80-004	94P3	4089
XL94-041	L91-281	US80-003	1436	XL94-094	L91-255	94P3	3018
XL94-042	US80-003	US80-003	0	XL94-095	HoCP89-846	LCP86-454	2970
XL94-043	HoCP89-846	LHo92-307	346	XL94-096	LCP86-454	LCP86-454	458
XL94-044	L91-281	L92-321	1357	XL94-098	CP72-370	CP77-407	1021
XL94-045	L92-321	L92-321	423	XL94-099	HoCP89-846	LCP82-089	3357
XL94-046	L91-281	LCP85-371	828	XL94-100	LCP81-010	LCP82-089	4724
XL94-047	L91-281	US79-010	808	XL94-101	US80-004	LCP82-089	4112
XL94-048	US79-010	US79-010	48	XL94-102	LCP82-089	LCP82-089	2709
XL94-049	LHo92-314	LCP85-384	1042	XL94-103	CP65-357	LCP85-384	2023
XL94-050	LCP81-010	LCP85-384	2344	XL94-104	CP72-370	LCP85-384	1355
XL94-051	L91-281	LCP85-384	1580	XL94-105	L92-309	LCP85-384	2575
XL94-052	LCP85-384	LCP85-384	185	XL94-106	HoCP89-846	LCP85-384	2548
XL94-053	US80-004	L93-395	1490	XL94-107	CP65-357	L93-395	432

Table 7. continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-108	CP72-370	L93-395	891	XL94-161	L89-113	LCP82-089	2038
XL94-109	CP72-370	L92-319	0	XL94-162	CP79-318	LCP82-089	2912
XL94-110	HoCP89-846	L92-319	7631	XL94-163	CP72-370	CP72-370	38
XL94-111	CP72-370	LHo92-314	1586	XL94-164	L89-113	LCP85-384	1906
XL94-112	HoCP89-846	LHo92-314	5332	XL94-165	CP70-330	LCP85-384	1286
XL94-113	HoCP89-846	L92-312	5609	XL94-166	HoCP88-739	LCP86-454	1067
XL94-114	CP79-318	L92-312	3716	XL94-167	HoCP89-846	LCP81-010	1363
XL94-115	CP65-357	L92-312	410	XL94-168	L91-250	LCP81-010	258
XL94-116	L92-312	L92-312	795	XL94-169	HoCP90-923	LCP81-010	234
XL94-117	LCP85-313	LCP86-454	1373	XL94-170	LCP81-010	LCP81-010	3070
XL94-118	CP79-318	L91-288	1920	XL94-171	CP79-348	LHo92-307	168
XL94-119	CP79-318	HoCP90-955	4705	XL94-172	LCP85-313	LHo92-307	316
XL94-120	CP65-357	HoCP90-955	1565	XL94-173	US80-004	LHo92-307	1323
XL94-121	HoCP89-846	HoCP90-955	998	XL94-174	CP79-318	L93-393	2258
XL94-122	CP72-370	HoCP90-955	982	XL94-175	HoCP89-846	L93-393	1875
XL94-123	HoCP90-955	HoCP90-955	88	XL94-176	CP72-370	L93-393	1106
XL94-124	HoCP89-846	CP76-331	4251	XL94-177	L93-393	L93-393	1201
XL94-125	LCP85-313	CP76-331	1468	XL94-178	CP65-357	LCP86-450	2650
XL94-126	US77-017	CP76-331	1585	XL94-179	HoCP89-846	LCP86-450	3571
XL94-127	HoCP89-846	L91-255	2578	XL94-180	LCP86-450	LCP86-450	574
XL94-128	HoCP89-846	LCP81-030	4031	XL94-181	HoCP88-739	L84-290	1112
XL94-129	LCP81-030	LCP81-030	255	XL94-183	CP65-357	L84-290	2862
XL94-130	L89-113	CP77-407	946	XL94-184	L84-290	L84-290	1070
XL94-131	CP79-348	L91-255	2008	XL94-185	CP65-357	CP78-317	1965
XL94-132	L89-113	LCP85-384	1006	XL94-186	HoCP89-846	CP78-317	1540
XL94-133	HoCP88-739	LCP85-384	254	XL94-187	CP78-317	CP78-317	624
XL94-134	CP70-330	LCP85-384	649	XL94-188	HoCP85-845	LCP85-384	3875
XL94-136	CP65-357	L88-072	1944	XL94-189	LCP86-450	LCP85-384	1513
XL94-137	CP65-357	CP76-331	1469	XL94-190	CP79-318	LCP85-384	4173
XL94-138	US77-017	CP76-331	1694	XL94-191	HoCP85-845	L84-290	2764
XL94-139	LCP81-010	CP76-331	2250	XL94-192	Ho89-889	CP76-331	3412
XL94-140	L85-294	CP76-331	2522	XL94-193	HoCP85-845	LCP81-030	2285
XL94-141	L85-294	L92-309	1768	XL94-194	US77-017	LCP81-030	1792
XL94-142	LCP81-010	L92-309	2655	XL94-195	CP79-318	LCP81-030	3453
XL94-143	L89-113	L92-309	486	XL94-196	HoCP85-845	LCP81-010	606
XL94-144	L92-309	L92-309	134	XL94-197	HoCP85-845	LCP82-089	5796
XL94-145	HoCP85-845	CP70-321	1101	XL94-198	LCP86-454	LCP82-089	3752
XL94-146	HoCP89-846	CP70-321	1933	XL94-199	L89-113	CP70-321	277
XL94-147	US77-017	CP70-321	1721	XL94-200	HoCP85-845	L92-310	3184
XL94-148	CP70-321	CP70-321	151	XL94-201	CP79-318	L92-310	4240
XL94-149	HoCP85-845	CP76-331	3350	XL94-202	L92-310	L92-310	2204
XL94-150	CP70-330	CP76-331	2391	XL94-203	L91-250	HoCP85-845	1435
XL94-151	US77-017	CP76-331	1613	XL94-204	L93-397	HoCP85-845	2023
XL94-152	HoCP85-845	CP72-370	1234	XL94-205	Ho89-889	HoCP85-845	1855
XL94-153	HoCP89-846	CP72-370	710	XL94-206	L92-349	LCP82-089	266
XL94-154	HoCP88-739	CP72-370	83	XL94-207	CP80-323	LCP82-089	2571
XL94-155	CP79-318	CP72-370	2454	XL94-208	L89-113	LCP82-089	1641
XL94-156	CP72-370	HoCP85-845	731	XL94-209	CP72-370	LCP82-089	464
XL94-157	CP79-318	HoCP85-845	2194	XL94-210	CP79-318	LCP82-089	3858
XL94-158	HoCP89-846	HoCP85-845	1523	XL94-211	CP79-318	LHo92-314	3847
XL94-159	HoCP90-923	HoCP85-845	590	XL94-212	L92-349	LCP85-384	689
XL94-160	HoCP85-845	HoCP85-845	175	XL94-213	CP80-323	LCP85-384	2703

Table 7. continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-214	L85-294	LCP85-384	1358	XL94-267	CP80-323	CP78-317	5014
XL94-215	L89-113	LCP85-384	1672	XL94-269	LCP83-137	LCP82-089	3809
XL94-216	US78-020	94P4	127	XL94-270	HoCP90-957	LCP82-089	2081
XL94-217	CP72-370	94P4	1007	XL94-271	LCP83-137	LCP85-384	2738
XL94-218	US80-003	94P4	1051	XL94-272	LCP83-137	Ho89-889	1276
XL94-219	L91-288	94P4	1484	XL94-273	L89-113	Ho89-889	310
XL94-220	L92-309	94P4	939	XL94-274	HoCP90-923	Ho89-889	272
XL94-221	L92-312	94P4	2042	XL94-275	Ho89-889	Ho89-889	798
XL94-222	HoCP85-845	94P4	3870	XL94-276	L89-113	CP80-323	1778
XL94-223	CP79-318	CP84-772	5013	XL94-277	HoCP85-845	CP80-323	1960
XL94-224	CP72-370	CP84-772	1464	XL94-278	CP80-323	CP80-323	2618
XL94-225	HoCP85-845	CP84-772	2510	XL94-279	CP72-370	US78-020	902
XL94-227	HoCP90-923	LCP86-454	1250	XL94-280	CP80-323	US78-020	2929
XL94-228	L89-113	HoCP88-769	1201	XL94-281	US78-020	US78-020	98
XL94-229	CP79-318	HoCP88-769	1343	XL94-282	CP70-321	US78-020	1166
XL94-230	L92-349	HoCP88-769	627	XL94-283	Ho89-889	US78-020	6502
XL94-231	HoCP88-769	HoCP88-769	76	XL94-284	CP70-330	US78-020	2701
XL94-232	L89-113	LCP81-030	1019	XL94-285	HoCP85-845	Ho89-889	1424
XL94-233	CP77-407	LCP82-089	3327	XL94-286	CP70-321	L84-290	102
XL94-234	US78-020	LCP82-089	3084	XL94-287	CP70-330	L84-290	1313
XL94-235	LCP85-313	LCP82-089	955	XL94-288	Ho89-889	L84-290	3313
XL94-236	CP72-370	LCP82-089	999	XL94-289	L92-349	L84-290	705
XL94-237	CP77-407	LCP85-384	1314	XL94-290	CP70-330	CP72-370	1558
XL94-238	US78-020	LCP85-384	1039	XL94-291	HoCP90-963	LHo92-314	341
XL94-239	L92-355	LCP85-384	2945	XL94-292	CP70-321	LHo92-314	810
XL94-240	CP70-321	HoCP85-845	581	XL94-293	L92-313	LCP86-450	943
XL94-241	CP80-323	HoCP85-845	1134	XL94-294	HoCP85-845	L88-072	1632
XL94-242	L89-113	HoCP85-845	397	XL94-295	Ho89-889	CP78-317	4681
XL94-243	CP72-370	HoCP85-845	1612	XL94-296	LHo83-153	LCP85-384	2203
XL94-244	HoCP85-845	94P5	6496	XL94-297	HoCP90-963	LCP85-384	870
XL94-245	LCP82-089	94P5	7535	XL94-298	CP83-644	LCP82-089	230
XL94-246	CP84-730	94P5	3634	XL94-299	CP70-330	L84-290	1379
XL94-247	CP70-321	94P6	1031	XL94-300	HoCP85-845	Ho89-889	634
XL94-248	CP80-323	94P6	2660	XL94-301	L92-349	Ho89-889	264
XL94-249	CP72-370	94P6	894	XL94-302	HoCP90-957	Ho89-889	235
XL94-250	L92-312	94P6	1178	XL94-303	L85-294	LCP82-089	4700
XL94-251	US78-020	LCP81-030	842	XL94-304	L89-163	LCP82-089	2845
XL94-252	HoCP90-923	LCP81-030	3208	XL94-305	HoCP90-957	L91-261	806
XL94-253	L89-113	LCP81-030	2155	XL94-306	L91-261	L91-261	131
XL94-254	CP79-318	LCP85-341	1498	XL94-307	L92-313	94P7	1685
XL94-255	HoCP89-846	LCP85-341	764	XL94-308	LCP81-010	94P7	4174
XL94-256	LCP83-137	LCP85-384	4142	XL94-309	L91-255	94P7	1274
XL94-257	US77-017	LCP85-384	1310	XL94-310	L91-264	94P7	1414
XL94-258	CP78-317	LCP85-384	4158	XL94-311	L89-113	HoCP90-957	238
XL94-259	LCP83-137	CP76-331	575	XL94-312	HoCP90-957	HoCP90-957	224
XL94-260	L89-113	CP76-331	1539	XL94-313	CP80-323	LCP83-137	316
XL94-261	US77-017	HoCP90-963	462	XL94-314	LCP83-137	LCP83-137	126
XL94-262	L89-113	HoCP90-963	400	XL94-315	CP70-330	CP83-644	1186
XL94-263	CP72-370	HoCP90-963	394	XL94-316	L89-163	CP83-644	2092
XL94-264	HoCP90-963	HoCP90-963	62	XL94-317	CP83-644	CP83-644	877
XL94-265	HoCP88-739	HoCP85-845	213	XL94-318	L89-163	L92-313	1954
XL94-266	HoCP90-963	HoCP85-845	125	XL94-319	HoCP85-845	L92-313	1402

Table 7. continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-320	L92-313	L92-313	185	XL94-330	CP72-370	94P9	1110
XL94-321	LHo83-153	Ho89-889	389	XL94-331	CP70-330	HoCP90-957	139
XL94-322	L89-163	CP70-321	480	XL94-332	CP78-317	CP77-310	2495
XL94-323	CP78-317	LCP85-384	384	XL94-333	CP70-330	CP79-348	847
XL94-324	US78-020	94P8	1690	XL94-334	CP79-348	CP79-348	1909
XL94-325	CP76-331	94P8	998	XL94-335	CP78-317	CP70-330	3671
XL94-326	HoCP90-957	94P8	1864	XL94-336	CP70-330	CP70-330	415
XL94-327	CP70-321	94P9	1364	Total			560989
XL94-328	LCP82-089	94P9	2930				
XL94-329	CP77-310	94P9	3664				

Table 8. Crosses and seed made in 1994 sorted by female parent.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-137	CP65-357	CP76-331	1469	XL94-163	CP72-370	CP72-370	38
XL94-185	CP65-357	CP78-317	1965	XL94-098	CP72-370	CP77-407	1021
XL94-120	CP65-357	HoCP90-955	1565	XL94-224	CP72-370	CP84-772	1464
XL94-183	CP65-357	L84-290	2862	XL94-122	CP72-370	HoCP90-955	982
XL94-136	CP65-357	L88-072	1944	XL94-263	CP72-370	HoCP90-963	394
XL94-115	CP65-357	L92-312	410	XL94-156	CP72-370	HoCP85-845	731
XL94-088	CP65-357	L92-319	2688	XL94-243	CP72-370	HoCP85-845	1612
XL94-107	CP65-357	L93-395	432	XL94-109	CP72-370	L92-319	0
XL94-103	CP65-357	LCP85-384	2023	XL94-176	CP72-370	L93-393	1106
XL94-178	CP65-357	LCP86-450	2650	XL94-108	CP72-370	L93-395	891
XL94-247	CP70-321	94P6	1031	XL94-209	CP72-370	LCP82-089	464
XL94-327	CP70-321	94P9	1364	XL94-236	CP72-370	LCP82-089	999
XL94-148	CP70-321	CP70-321	151	XL94-104	CP72-370	LCP85-384	1355
XL94-240	CP70-321	HoCP85-845	581	XL94-111	CP72-370	LHo92-314	1586
XL94-286	CP70-321	L84-290	102	XL94-279	CP72-370	US78-020	902
XL94-292	CP70-321	LHo92-314	810	XL94-325	CP76-331	94P8	998
XL94-282	CP70-321	US78-020	1166	XL94-060	CP76-331	CP76-331	745
XL94-336	CP70-330	CP70-330	415	XL94-329	CP77-310	94P9	3664
XL94-290	CP70-330	CP72-370	1558	XL94-067	CP77-310	CP77-310	1038
XL94-150	CP70-330	CP76-331	2391	XL94-004	CP77-405	CP77-405	1940
XL94-333	CP70-330	CP79-348	847	XL94-063	CP77-405	L88-072	1922
XL94-315	CP70-330	CP83-644	1186	XL94-021	CP77-405	L91-288	629
XL94-331	CP70-330	HoCP90-957	139	XL94-025	CP77-405	L92-337	1455
XL94-287	CP70-330	L84-290	1313	XL94-006	CP77-405	LHo92-307	2028
XL94-299	CP70-330	L84-290	1379	XL94-233	CP77-407	LCP82-089	3327
XL94-134	CP70-330	LCP85-384	649	XL94-237	CP77-407	LCP85-384	1314
XL94-165	CP70-330	LCP85-384	1286	XL94-335	CP78-317	CP70-330	3671
XL94-284	CP70-330	US78-020	2701	XL94-332	CP78-317	CP77-310	2495
XL94-217	CP72-370	94P4	1007	XL94-187	CP78-317	CP78-317	624
XL94-249	CP72-370	94P6	894	XL94-258	CP78-317	LCP85-384	4158
XL94-330	CP72-370	94P9	1110	XL94-323	CP78-317	LCP85-384	384

Table 8. Continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-155	CP79-318	CP72-370	2454	XL94-113	HoCP89-846	L92-312	5609
XL94-071	CP79-318	CP77-310	2494	XL94-087	HoCP89-846	L92-319	2589
XL94-223	CP79-318	CP84-772	5013	XL94-110	HoCP89-846	L92-319	7631
XL94-229	CP79-318	HoCP88-769	1343	XL94-175	HoCP89-846	L93-393	1875
XL94-119	CP79-318	HoCP90-955	4705	XL94-055	HoCP89-846	L93-395	907
XL94-157	CP79-318	HoCP85-845	2194	XL94-167	HoCP89-846	LCP81-010	1363
XL94-118	CP79-318	L91-288	1920	XL94-128	HoCP89-846	LCP81-030	4031
XL94-201	CP79-318	L92-310	4240	XL94-099	HoCP89-846	LCP82-089	3357
XL94-114	CP79-318	L92-312	3716	XL94-255	HoCP89-846	LCP85-341	764
XL94-174	CP79-318	L93-393	2258	XL94-106	HoCP89-846	LCP85-384	2548
XL94-195	CP79-318	LCP81-030	3453	XL94-179	HoCP89-846	LCP86-450	3571
XL94-162	CP79-318	LCP82-089	2912	XL94-095	HoCP89-846	LCP86-454	2970
XL94-210	CP79-318	LCP82-089	3858	XL94-043	HoCP89-846	LHo92-307	346
XL94-254	CP79-318	LCP85-341	1498	XL94-112	HoCP89-846	LHo92-314	5332
XL94-084	CP79-318	LCP85-384	4324	XL94-074	HoCP89-846	US77-010	1527
XL94-190	CP79-318	LCP85-384	4173	XL94-086	HoCP89-846	US79-010	1321
XL94-211	CP79-318	LHo92-314	3847	XL94-062	HoCP89-846	US80-003	135
XL94-075	CP79-318	US77-010	4700	XL94-192	Ho89-889	CP76-331	3412
XL94-061	CP79-318	US79-010	2453	XL94-295	Ho89-889	CP78-317	4681
XL94-003	CP79-348	CP77-405	877	XL94-275	Ho89-889	Ho89-889	798
XL94-334	CP79-348	CP79-348	1909	XL94-205	Ho89-889	HoCP85-845	1855
XL94-008	CP79-348	HoCP91-552	1226	XL94-288	Ho89-889	L84-290	3313
XL94-131	CP79-348	L91-255	2008	XL94-085	Ho89-889	LCP85-384	7040
XL94-022	CP79-348	L91-288	750	XL94-283	Ho89-889	US78-020	6502
XL94-001	CP79-348	LCP85-371	1156	XL94-274	HoCP90-923	Ho89-889	272
XL94-171	CP79-348	LHo92-307	168	XL94-159	HoCP90-923	HoCP85-845	590
XL94-248	CP80-323	94P6	2660	XL94-169	HoCP90-923	LCP81-010	234
XL94-267	CP80-323	CP78-317	5014	XL94-252	HoCP90-923	LCP81-030	3208
XL94-278	CP80-323	CP80-323	2618	XL94-227	HoCP90-923	LCP86-454	1250
XL94-241	CP80-323	HoCP85-845	1134	XL94-010	HoCP90-941	94P1	1612
XL94-207	CP80-323	LCP82-089	2571	XL94-081	HoCP90-941	94P2	533
XL94-313	CP80-323	LCP83-137	316	XL94-029	HoCP90-941	HoCP90-941	482
XL94-213	CP80-323	LCP85-384	2703	XL94-013	HoCP90-941	HoCP91-552	2397
XL94-280	CP80-323	US78-020	2929	XL94-123	HoCP90-955	HoCP90-955	88
XL94-317	CP83-644	CP83-644	877	XL94-005	HoCP90-955	LHo92-307	191
XL94-298	CP83-644	LCP82-089	230	XL94-326	HoCP90-957	94P8	1864
XL94-246	CP84-730	94P5	3634	XL94-302	HoCP90-957	Ho89-889	235
XL94-040	CP84-772	CP84-772	793	XL94-312	HoCP90-957	HoCP90-957	224
XL94-154	HoCP88-739	CP72-370	83	XL94-305	HoCP90-957	L91-261	806
XL94-265	HoCP88-739	HoCP85-845	213	XL94-270	HoCP90-957	LCP82-089	2081
XL94-181	HoCP88-739	L84-290	1112	XL94-264	HoCP90-963	HoCP90-963	62
XL94-133	HoCP88-739	LCP85-384	254	XL94-266	HoCP90-963	HoCP85-845	125
XL94-166	HoCP88-739	LCP86-454	1067	XL94-297	HoCP90-963	LCP85-384	870
XL94-231	HoCP88-769	HoCP88-769	76	XL94-291	HoCP90-963	LHo92-314	341
XL94-146	HoCP89-846	CP70-321	1933	XL94-009	HoCP91-552	HoCP91-552	3032
XL94-153	HoCP89-846	CP72-370	710	XL94-222	HoCP85-845	94P4	3870
XL94-124	HoCP89-846	CP76-331	4251	XL94-244	HoCP85-845	94P5	6496
XL94-066	HoCP89-846	CP77-310	3126	XL94-145	HoCP85-845	CP70-321	1101
XL94-186	HoCP89-846	CP78-317	1540	XL94-152	HoCP85-845	CP72-370	1234
XL94-121	HoCP89-846	HoCP90-955	998	XL94-149	HoCP85-845	CP76-331	3350
XL94-158	HoCP89-846	HoCP85-845	1523	XL94-277	HoCP85-845	CP80-323	1960
XL94-127	HoCP89-846	L91-255	2578	XL94-225	HoCP85-845	CP84-772	2510

Table 8. Continued.

Cross	Female	Male	Seed
XL94-285	HoCP85-845	Ho89-889	1424
XL94-300	HoCP85-845	Ho89-889	634
XL94-160	HoCP85-845	HoCP85-845	175
XL94-191	HoCP85-845	L84-290	2764
XL94-294	HoCP85-845	L88-072	1632
XL94-200	HoCP85-845	L92-310	3184
XL94-319	HoCP85-845	L92-313	1402
XL94-196	HoCP85-845	LCP81-010	606
XL94-193	HoCP85-845	LCP81-030	2285
XL94-197	HoCP85-845	LCP82-089	5796
XL94-188	HoCP85-845	LCP85-384	3875
XL94-184	L84-290	L84-290	1070
XL94-140	L85-294	CP76-331	2522
XL94-141	L85-294	L92-309	1768
XL94-303	L85-294	LCP82-089	4700
XL94-214	L85-294	LCP85-384	1358
XL94-031	L88-072	L88-072	282
XL94-132	L89-113	LCP85-384	1006
XL94-199	L89-113	CP70-321	277
XL94-260	L89-113	CP76-331	1539
XL94-130	L89-113	CP77-407	946
XL94-276	L89-113	CP80-323	1778
XL94-228	L89-113	HoCP88-769	1201
XL94-273	L89-113	Ho89-889	310
XL94-311	L89-113	HoCP90-957	238
XL94-262	L89-113	HoCP90-963	400
XL94-242	L89-113	HoCP85-845	397
XL94-143	L89-113	L92-309	486
XL94-232	L89-113	LCP81-030	1019
XL94-253	L89-113	LCP81-030	2155
XL94-161	L89-113	LCP82-089	2038
XL94-208	L89-113	LCP82-089	1641
XL94-164	L89-113	LCP85-384	1906
XL94-215	L89-113	LCP85-384	1672
XL94-322	L89-163	CP70-321	480
XL94-316	L89-163	CP83-644	2092
XL94-318	L89-163	L92-313	1954
XL94-304	L89-163	LCP82-089	2845
XL94-203	L91-250	HoCP85-845	1435
XL94-168	L91-250	LCP81-010	258
XL94-094	L91-255	94P3	3018
XL94-309	L91-255	94P7	1274
XL94-018	L91-255	L91-255	529
XL94-306	L91-261	L91-261	131
XL94-310	L91-264	94P7	1414
XL94-032	L91-281	HoCP90-941	1124
XL94-014	L91-281	HoCP91-552	3557
XL94-034	L91-281	L88-072	895
XL94-079	L91-281	L91-281	11
XL94-044	L91-281	L92-321	1357
XL94-046	L91-281	LCP85-371	828
XL94-051	L91-281	LCP85-384	1580
XL94-020	L91-281	LHo92-307	116
XL94-047	L91-281	US79-010	808
XL94-041	L91-281	US80-003	1436
XL94-219	L91-288	94P4	1484
XL94-033	L91-288	HoCP90-941	484
XL94-036	L91-288	L91-255	3178
XL94-023	L91-288	L91-288	197
XL94-220	L92-309	94P4	939
XL94-144	L92-309	L92-309	134
XL94-105	L92-309	LCP85-384	2575
XL94-202	L92-310	L92-310	2204
XL94-221	L92-312	94P4	2042
XL94-250	L92-312	94P6	1178
XL94-116	L92-312	L92-312	795
XL94-307	L92-313	94P7	1685
XL94-320	L92-313	L92-313	185
XL94-293	L92-313	LCP86-450	943
XL94-089	L92-319	L92-319	319
XL94-011	L92-321	94P1	1589
XL94-045	L92-321	L92-321	423
XL94-016	L92-322	L91-255	2855
XL94-026	L92-337	L92-337	91
XL94-230	L92-349	HoCP88-769	627
XL94-301	L92-349	Ho89-889	264
XL94-289	L92-349	L84-290	705
XL94-206	L92-349	LCP82-089	266
XL94-212	L92-349	LCP85-384	689
XL94-239	L92-355	LCP85-384	2945
XL94-038	L93-363	CP84-772	873
XL94-177	L93-393	L93-393	1201
XL94-056	L93-395	L93-395	372
XL94-204	L93-397	HoCP85-845	2023
XL94-308	LCP81-010	94P7	4174
XL94-139	LCP81-010	CP76-331	2250
XL94-037	LCP81-010	L91-255	1411
XL94-142	LCP81-010	L92-309	2655
XL94-170	LCP81-010	LCP81-010	3070
XL94-100	LCP81-010	LCP82-089	4724
XL94-050	LCP81-010	LCP85-384	2344
XL94-080	LCP81-030	94P2	626
XL94-129	LCP81-030	LCP81-030	255
XL94-245	LCP82-089	94P5	7535
XL94-328	LCP82-089	94P9	2930
XL94-102	LCP82-089	LCP82-089	2709
XL94-259	LCP83-137	CP76-331	575
XL94-272	LCP83-137	Ho89-889	1276
XL94-269	LCP83-137	LCP82-089	3809
XL94-314	LCP83-137	LCP83-137	126
XL94-256	LCP83-137	LCP85-384	4142
XL94-271	LCP83-137	LCP85-384	2738
XL94-082	LCP85-313	94P2	153
XL94-125	LCP85-313	CP76-331	1468

Table 8. Continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-077	LCP85-313	L91-281	0	XL94-007	LHo92-307	LHo92-307	467
XL94-054	LCP85-313	L93-395	569	XL94-065	LHo92-314	CP77-310	1698
XL94-235	LCP85-313	LCP82-089	955	XL94-049	LHo92-314	LCP85-384	1042
XL94-068	LCP85-313	LCP85-384	1696	XL94-091	LHo92-314	LHo92-314	428
XL94-117	LCP85-313	LCP86-454	1373	XL94-076	US77-010	US77-010	2226
XL94-172	LCP85-313	LHo92-307	316	XL94-147	US77-017	CP70-321	1721
XL94-090	LCP85-313	LHo92-314	1583	XL94-126	US77-017	CP76-331	1585
XL94-058	LCP85-341	CP76-331	998	XL94-138	US77-017	CP76-331	1694
XL94-027	LCP85-341	HoCP90-941	1182	XL94-151	US77-017	CP76-331	1613
XL94-030	LCP85-341	L88-072	1159	XL94-261	US77-017	HoCP90-963	462
XL94-012	LCP85-371	94P1	1187	XL94-194	US77-017	LCP81-030	1792
XL94-002	LCP85-371	LCP85-371	320	XL94-257	US77-017	LCP85-384	1310
XL94-052	LCP85-384	LCP85-384	185	XL94-216	US78-020	94P4	127
XL94-039	LCP86-429	CP84-772	1085	XL94-324	US78-020	94P8	1690
XL94-028	LCP86-429	HoCP90-941	3938	XL94-251	US78-020	LCP81-030	842
XL94-015	LCP86-429	HoCP91-552	3340	XL94-234	US78-020	LCP82-089	3084
XL94-035	LCP86-429	L88-072	1296	XL94-238	US78-020	LCP85-384	1039
XL94-017	LCP86-429	L91-255	3717	XL94-281	US78-020	US78-020	98
XL94-019	LCP86-429	LHo92-307	308	XL94-048	US79-010	US79-010	48
XL94-189	LCP86-450	LCP85-384	1513	XL94-092	US80-003	94P3	1378
XL94-180	LCP86-450	LCP86-450	574	XL94-218	US80-003	94P4	1051
XL94-070	LCP86-454	CP77-310	1860	XL94-042	US80-003	US80-003	0
XL94-078	LCP86-454	L91-281	95	XL94-093	US80-004	94P3	4089
XL94-198	LCP86-454	LCP82-089	3752	XL94-057	US80-004	CP76-331	2262
XL94-096	LCP86-454	LCP86-454	458	XL94-064	US80-004	L88-072	1203
XL94-073	LCP86-454	US77-010	2845	XL94-053	US80-004	L93-395	1490
XL94-072	LCP86-454	US79-010	366	XL94-101	US80-004	LCP82-089	4112
XL94-321	LHo83-153	Ho89-889	389	XL94-069	US80-004	LCP85-384	2202
XL94-296	LHo83-153	LCP85-384	2203	XL94-173	US80-004	LHo92-307	1323
				Total			560989

Table 9. Crosses and seed made in 1994 sorted by male parent.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-010	HoCP90-941	94P1	1612	XL94-246	CP84-730	94P5	3634
XL94-011	L92-321	94P1	1589	XL94-244	HoCP85-845	94P5	6496
XL94-012	LCP85-371	94P1	1187	XL94-245	LCP82-089	94P5	7535
XL94-081	HoCP90-941	94P2	533	XL94-247	CP70-321	94P6	1031
XL94-080	LCP81-030	94P2	626	XL94-249	CP72-370	94P6	894
XL94-082	LCP85-313	94P2	153	XL94-248	CP80-323	94P6	2660
XL94-094	L91-255	94P3	3018	XL94-250	L92-312	94P6	1178
XL94-092	US80-003	94P3	1378	XL94-309	L91-255	94P7	1274
XL94-093	US80-004	94P3	4089	XL94-310	L91-264	94P7	1414
XL94-217	CP72-370	94P4	1007	XL94-307	L92-313	94P7	1685
XL94-222	HoCP85-845	94P4	3870	XL94-308	LCP81-010	94P7	4174
XL94-219	L91-288	94P4	1484	XL94-325	CP76-331	94P8	998
XL94-220	L92-309	94P4	939	XL94-326	HoCP90-957	94P8	1864
XL94-221	L92-312	94P4	2042	XL94-324	US78-020	94P8	1690
XL94-216	US78-020	94P4	127	XL94-327	CP70-321	94P9	1364
XL94-218	US80-003	94P4	1051	XL94-330	CP72-370	94P9	1110

Table 9. Continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-329	CP77-310	94P9	3664	XL94-315	CP70-330	CP83-644	1186
XL94-328	LCP82-089	94P9	2930	XL94-317	CP83-644	CP83-644	877
XL94-148	CP70-321	CP70-321	151	XL94-316	L89-163	CP83-644	2092
XL94-146	HoCP89-846	CP70-321	1933	XL94-224	CP72-370	CP84-772	1464
XL94-145	HoCP85-845	CP70-321	1101	XL94-223	CP79-318	CP84-772	5013
XL94-199	L89-113	CP70-321	277	XL94-040	CP84-772	CP84-772	793
XL94-322	L89-163	CP70-321	480	XL94-225	HoCP85-845	CP84-772	2510
XL94-147	US77-017	CP70-321	1721	XL94-038	L93-363	CP84-772	873
XL94-336	CP70-330	CP70-330	415	XL94-039	LCP86-429	CP84-772	1085
XL94-335	CP78-317	CP70-330	3671	XL94-229	CP79-318	HoCP88-769	1343
XL94-290	CP70-330	CP72-370	1558	XL94-231	HoCP88-769	HoCP88-769	76
XL94-163	CP72-370	CP72-370	38	XL94-228	L89-113	HoCP88-769	1201
XL94-155	CP79-318	CP72-370	2454	XL94-230	L92-349	HoCP88-769	627
XL94-154	HoCP88-739	CP72-370	83	XL94-275	Ho89-889	Ho89-889	798
XL94-153	HoCP89-846	CP72-370	710	XL94-274	HoCP90-923	Ho89-889	272
XL94-152	HoCP85-845	CP72-370	1234	XL94-302	HoCP90-957	Ho89-889	235
XL94-137	CP65-357	CP76-331	1469	XL94-285	HoCP85-845	Ho89-889	1424
XL94-150	CP70-330	CP76-331	2391	XL94-300	HoCP85-845	Ho89-889	634
XL94-060	CP76-331	CP76-331	745	XL94-273	L89-113	Ho89-889	310
XL94-124	HoCP89-846	CP76-331	4251	XL94-301	L92-349	Ho89-889	264
XL94-192	Ho89-889	CP76-331	3412	XL94-272	LCP83-137	Ho89-889	1276
XL94-149	HoCP85-845	CP76-331	3350	XL94-321	LHo83-153	Ho89-889	389
XL94-140	L85-294	CP76-331	2522	XL94-029	HoCP90-941	HoCP90-941	482
XL94-260	L89-113	CP76-331	1539	XL94-032	L91-281	HoCP90-941	1124
XL94-139	LCP81-010	CP76-331	2250	XL94-033	L91-288	HoCP90-941	484
XL94-259	LCP83-137	CP76-331	575	XL94-027	LCP85-341	HoCP90-941	1182
XL94-125	LCP85-313	CP76-331	1468	XL94-028	LCP86-429	HoCP90-941	3938
XL94-058	LCP85-341	CP76-331	998	XL94-120	CP65-357	HoCP90-955	1565
XL94-126	US77-017	CP76-331	1585	XL94-122	CP72-370	HoCP90-955	982
XL94-138	US77-017	CP76-331	1694	XL94-119	CP79-318	HoCP90-955	4705
XL94-151	US77-017	CP76-331	1613	XL94-121	HoCP89-846	HoCP90-955	998
XL94-057	US80-004	CP76-331	2262	XL94-123	HoCP90-955	HoCP90-955	88
XL94-067	CP77-310	CP77-310	1038	XL94-331	CP70-330	HoCP90-957	139
XL94-332	CP78-317	CP77-310	2495	XL94-312	HoCP90-957	HoCP90-957	224
XL94-071	CP79-318	CP77-310	2494	XL94-311	L89-113	HoCP90-957	238
XL94-066	HoCP89-846	CP77-310	3126	XL94-263	CP72-370	HoCP90-963	394
XL94-070	LCP86-454	CP77-310	1860	XL94-264	HoCP90-963	HoCP90-963	62
XL94-065	LHo92-314	CP77-310	1698	XL94-262	L89-113	HoCP90-963	400
XL94-004	CP77-405	CP77-405	1940	XL94-261	US77-017	HoCP90-963	462
XL94-003	CP79-348	CP77-405	877	XL94-008	CP79-348	HoCP91-552	1226
XL94-098	CP72-370	CP77-407	1021	XL94-013	HoCP90-941	HoCP91-552	2397
XL94-130	L89-113	CP77-407	946	XL94-009	HoCP91-552	HoCP91-552	3032
XL94-185	CP65-357	CP78-317	1965	XL94-014	L91-281	HoCP91-552	3557
XL94-187	CP78-317	CP78-317	624	XL94-015	LCP86-429	HoCP91-552	3340
XL94-267	CP80-323	CP78-317	5014	XL94-240	CP70-321	HoCP85-845	581
XL94-186	HoCP89-846	CP78-317	1540	XL94-156	CP72-370	HoCP85-845	731
XL94-295	Ho89-889	CP78-317	4681	XL94-243	CP72-370	HoCP85-845	1612
XL94-333	CP70-330	CP79-348	847	XL94-157	CP79-318	HoCP85-845	2194
XL94-334	CP79-348	CP79-348	1909	XL94-241	CP80-323	HoCP85-845	1134
XL94-278	CP80-323	CP80-323	2618	XL94-265	HoCP88-739	HoCP85-845	213
XL94-277	HoCP85-845	CP80-323	1960	XL94-158	HoCP89-846	HoCP85-845	1523
XL94-276	L89-113	CP80-323	1778	XL94-205	Ho89-889	HoCP85-845	1855

Table 9. Continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-159	HoCP90-923	HoCP85-845	590	XL94-320	L92-313	L92-313	185
XL94-266	HoCP90-963	HoCP85-845	125	XL94-088	CP65-357	L92-319	2688
XL94-160	HoCP85-845	HoCP85-845	175	XL94-109	CP72-370	L92-319	0
XL94-242	L89-113	HoCP85-845	397	XL94-087	HoCP89-846	L92-319	2589
XL94-203	L91-250	HoCP85-845	1435	XL94-110	HoCP89-846	L92-319	7631
XL94-204	L93-397	HoCP85-845	2023	XL94-089	L92-319	L92-319	319
XL94-183	CP65-357	L84-290	2862	XL94-044	L91-281	L92-321	1357
XL94-286	CP70-321	L84-290	102	XL94-045	L92-321	L92-321	423
XL94-287	CP70-330	L84-290	1313	XL94-025	CP77-405	L92-337	1455
XL94-299	CP70-330	L84-290	1379	XL94-026	L92-337	L92-337	91
XL94-181	HoCP88-739	L84-290	1112	XL94-176	CP72-370	L93-393	1106
XL94-288	Ho89-889	L84-290	3313	XL94-174	CP79-318	L93-393	2258
XL94-191	HoCP85-845	L84-290	2764	XL94-175	HoCP89-846	L93-393	1875
XL94-184	L84-290	L84-290	1070	XL94-177	L93-393	L93-393	1201
XL94-289	L92-349	L84-290	705	XL94-107	CP65-357	L93-395	432
XL94-136	CP65-357	L88-072	1944	XL94-108	CP72-370	L93-395	891
XL94-063	CP77-405	L88-072	1922	XL94-055	HoCP89-846	L93-395	907
XL94-294	HoCP85-845	L88-072	1632	XL94-056	L93-395	L93-395	372
XL94-031	L88-072	L88-072	282	XL94-054	LCP85-313	L93-395	569
XL94-034	L91-281	L88-072	895	XL94-053	US80-004	L93-395	1490
XL94-030	LCP85-341	L88-072	1159	XL94-167	HoCP89-846	LCP81-010	1363
XL94-035	LCP86-429	L88-072	1296	XL94-169	HoCP90-923	LCP81-010	234
XL94-064	US80-004	L88-072	1203	XL94-196	HoCP85-845	LCP81-010	606
XL94-131	CP79-348	L91-255	2008	XL94-168	L91-250	LCP81-010	258
XL94-127	HoCP89-846	L91-255	2578	XL94-170	LCP81-010	LCP81-010	3070
XL94-018	L91-255	L91-255	529	XL94-195	CP79-318	LCP81-030	3453
XL94-036	L91-288	L91-255	3178	XL94-128	HoCP89-846	LCP81-030	4031
XL94-016	L92-322	L91-255	2855	XL94-252	HoCP90-923	LCP81-030	3208
XL94-037	LCP81-010	L91-255	1411	XL94-193	HoCP85-845	LCP81-030	2285
XL94-017	LCP86-429	L91-255	3717	XL94-232	L89-113	LCP81-030	1019
XL94-305	HoCP90-957	L91-261	806	XL94-253	L89-113	LCP81-030	2155
XL94-306	L91-261	L91-261	131	XL94-129	LCP81-030	LCP81-030	255
XL94-079	L91-281	L91-281	11	XL94-194	US77-017	LCP81-030	1792
XL94-077	LCP85-313	L91-281	0	XL94-251	US78-020	LCP81-030	842
XL94-078	LCP86-454	L91-281	95	XL94-209	CP72-370	LCP82-089	464
XL94-021	CP77-405	L91-288	629	XL94-236	CP72-370	LCP82-089	999
XL94-118	CP79-318	L91-288	1920	XL94-233	CP77-407	LCP82-089	3327
XL94-022	CP79-348	L91-288	750	XL94-162	CP79-318	LCP82-089	2912
XL94-023	L91-288	L91-288	197	XL94-210	CP79-318	LCP82-089	3858
XL94-141	L85-294	L92-309	1768	XL94-207	CP80-323	LCP82-089	2571
XL94-143	L89-113	L92-309	486	XL94-298	CP83-644	LCP82-089	230
XL94-144	L92-309	L92-309	134	XL94-099	HoCP89-846	LCP82-089	3357
XL94-142	LCP81-010	L92-309	2655	XL94-270	HoCP90-957	LCP82-089	2081
XL94-201	CP79-318	L92-310	4240	XL94-197	HoCP85-845	LCP82-089	5796
XL94-200	HoCP85-845	L92-310	3184	XL94-303	L85-294	LCP82-089	4700
XL94-202	L92-310	L92-310	2204	XL94-161	L89-113	LCP82-089	2038
XL94-115	CP65-357	L92-312	410	XL94-208	L89-113	LCP82-089	1641
XL94-114	CP79-318	L92-312	3716	XL94-304	L89-163	LCP82-089	2845
XL94-113	HoCP89-846	L92-312	5609	XL94-206	L92-349	LCP82-089	266
XL94-116	L92-312	L92-312	795	XL94-100	LCP81-010	LCP82-089	4724
XL94-319	HoCP85-845	L92-313	1402	XL94-102	LCP82-089	LCP82-089	2709
XL94-318	L89-163	L92-313	1954	XL94-269	LCP83-137	LCP82-089	3809

Table 9. Continued.

Cross	Female	Male	Seed	Cross	Female	Male	Seed
XL94-235	LCP85-313	LCP82-089	955	XL94-069	US80-004	LCP85-384	2202
XL94-198	LCP86-454	LCP82-089	3752	XL94-178	CP65-357	LCP86-450	2650
XL94-234	US78-020	LCP82-089	3084	XL94-179	HoCP89-846	LCP86-450	3571
XL94-101	US80-004	LCP82-089	4112	XL94-293	L92-313	LCP86-450	943
XL94-313	CP80-323	LCP83-137	316	XL94-180	LCP86-450	LCP86-450	574
XL94-314	LCP83-137	LCP83-137	126	XL94-166	HoCP88-739	LCP86-454	1067
XL94-254	CP79-318	LCP85-341	1498	XL94-095	HoCP89-846	LCP86-454	2970
XL94-255	HoCP89-846	LCP85-341	764	XL94-227	HoCP90-923	LCP86-454	1250
XL94-001	CP79-348	LCP85-371	1156	XL94-117	LCP85-313	LCP86-454	1373
XL94-046	L91-281	LCP85-371	828	XL94-096	LCP86-454	LCP86-454	458
XL94-002	LCP85-371	LCP85-371	320	XL94-006	CP77-405	LHo92-307	2028
XL94-103	CP65-357	LCP85-384	2023	XL94-171	CP79-348	LHo92-307	168
XL94-134	CP70-330	LCP85-384	649	XL94-043	HoCP89-846	LHo92-307	346
XL94-165	CP70-330	LCP85-384	1286	XL94-005	HoCP90-955	LHo92-307	191
XL94-104	CP72-370	LCP85-384	1355	XL94-020	L91-281	LHo92-307	116
XL94-237	CP77-407	LCP85-384	1314	XL94-172	LCP85-313	LHo92-307	316
XL94-258	CP78-317	LCP85-384	4158	XL94-019	LCP86-429	LHo92-307	308
XL94-323	CP78-317	LCP85-384	384	XL94-007	LHo92-307	LHo92-307	467
XL94-084	CP79-318	LCP85-384	4324	XL94-173	US80-004	LHo92-307	1323
XL94-190	CP79-318	LCP85-384	4173	XL94-292	CP70-321	LHo92-314	810
XL94-213	CP80-323	LCP85-384	2703	XL94-111	CP72-370	LHo92-314	1586
XL94-133	HoCP88-739	LCP85-384	254	XL94-211	CP79-318	LHo92-314	3847
XL94-083	HoCP89-846	LCP85-384	2681	XL94-112	HoCP89-846	LHo92-314	5332
XL94-106	HoCP89-846	LCP85-384	2548	XL94-291	HoCP90-963	LHo92-314	341
XL94-085	Ho89-889	LCP85-384	7040	XL94-090	LCP85-313	LHo92-314	1583
XL94-297	HoCP90-963	LCP85-384	870	XL94-091	LHo92-314	LHo92-314	428
XL94-188	HoCP85-845	LCP85-384	3875	XL94-075	CP79-318	US77-010	4700
XL94-214	L85-294	LCP85-384	1358	XL94-074	HoCP89-846	US77-010	1527
XL94-132	L89-113	LCP85-384	1006	XL94-073	LCP86-454	US77-010	2845
XL94-164	L89-113	LCP85-384	1906	XL94-076	US77-010	US77-010	2226
XL94-215	L89-113	LCP85-384	1672	XL94-282	CP70-321	US78-020	1166
XL94-051	L91-281	LCP85-384	1580	XL94-284	CP70-330	US78-020	2701
XL94-105	L92-309	LCP85-384	2575	XL94-279	CP72-370	US78-020	902
XL94-212	L92-349	LCP85-384	689	XL94-280	CP80-323	US78-020	2929
XL94-239	L92-355	LCP85-384	2945	XL94-283	Ho89-889	US78-020	6502
XL94-050	LCP81-010	LCP85-384	2344	XL94-281	US78-020	US78-020	98
XL94-256	LCP83-137	LCP85-384	4142	XL94-061	CP79-318	US79-010	2453
XL94-271	LCP83-137	LCP85-384	2738	XL94-086	HoCP89-846	US79-010	1321
XL94-068	LCP85-313	LCP85-384	1696	XL94-047	L91-281	US79-010	808
XL94-052	LCP85-384	LCP85-384	185	XL94-072	LCP86-454	US79-010	366
XL94-189	LCP86-450	LCP85-384	1513	XL94-048	US79-010	US79-010	48
XL94-296	LHo83-153	LCP85-384	2203	XL94-062	HoCP89-846	US80-003	135
XL94-049	LHo92-314	LCP85-384	1042	XL94-041	L91-281	US80-003	1436
XL94-257	US77-017	LCP85-384	1310	XL94-042	US80-003	US80-003	0
XL94-238	US78-020	LCP85-384	1039	Total			560989

SELECTIONS, ADVANCEMENTS, AND ASSIGNMENTS OF THE LOUISIANA, "L", SUGARCANE VARIETY DEVELOPMENT PROGRAM FOR THE YEAR 1994

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In the selection stage of the Louisiana Sugarcane Variety Development Program, clones of desirable phenotype are advanced through single stool seedling, first line, second line, and increase stages (Table 1). At the end of this stage, each clone that is judged to have breeding or commercial value is assigned a permanent variety number and advanced to the nursery stage of testing.

In April 1994, 68,900 seedlings from 213 crosses were transplanted to the field. The majority of the seedlings (50,554 from 160 crosses) were scheduled for routine selection. Eleven thousand nine hundred sixty-eight seedlings from 188 crosses were transplanted into a replicated cross appraisal test at the St. Gabriel Research Station. An additional 6,400 seedlings from 25 crosses were planted into a replicated cross by location by intrarow spacing study at the St. Gabriel Research Station and the USDA research station at Chacahoula (each location had 3,200 seedlings).

In the first stage of advancement, stalks from selected stubble-single stool seedlings are used to plant the first line trial. The 1992 crossing series was at this stage in 1994. Family selection was imposed prior to single plant selection within the selected families. Family selection was based on replicated cross appraisal test data. Of the 49,655 overwintering progeny from 106 crosses planted in the regular single plant selection stage (Seedling Stage), 23,605 progeny (47.5% of overwintering progeny) from 56 crosses (52.8% of originally planted families) were initially selected. From the selected families, 21.3% or 5033 single plant selections were made. Of these, 2045 (40.6%) were discarded for insufficient Brix. The remaining 2988 were planted as first-line trials (Table 1). The task of hauling the two-stalk bundles of single plant selections from the field was made easier in 1994 by pulling a narrow cart between the rows with a four wheel all-terrain vehicle. This method also reduced the chance of error, since fewer people handled the selections.

Cane yield rating for first line selections of the 1991 crossing series suggest that there were fewer poor yielding individuals (ratings >6) and more high yielding (ratings <5) clones than in previous years (Table 2a). Factors that could have contributed include a mild winter, improved weed control, improved crosses, and the use of family selection prior to individual selection of plants. The mild winter and adequate rain in 1994 apparently supported conditions for high borer and smut pressure and the low pithiness observed at the St. Gabriel Research Station (tables 2a, 2b, and 3). Eight hundred-forty two clones were advanced to second line trials.

This project was partially funded by the American Sugar Cane League.

Leaf scald was found on the St. Gabriel Research Station in the fall of 1994 by selection personnel in the second-line trials. Because of the insidious nature of the disease, it is expected that the disease is in latent form throughout the station. The discovery of leaf scald at St. Gabriel enables the resumption of the movement of clones from verified leaf scald infected areas to St. Gabriel.

Selecting clones of the 1990 crossing series for advancement from second line trials to increase stage began with counting stalks and inspecting for smut in each clone. About 41% of the initial 670 clones were eliminated for low stalk number (Table 3). Of those passing this initial screen, borer damage was the most prominent reason for dropping clones. The 288 clones advanced to the increase stage of the program were evaluated for sucrose content.

Of the initial 202 clones in the increase stage of the 1989 crossing series, 45 were assigned variety numbers in 1994. A list of the 1994 assignments and a summary of all current data for these assignments is provide in Table 4. It should be noted that plant cane data from the increase replications were collected after the assignments of permanent numbers and planting the nursery plots.

Traditionally the relative value of sugarcane crosses has been estimated by comparing the relative percent advancements through the respective stages of selection. With this method the best estimates come after several years of advancement. The advancement summaries for the crosses from the 1986 through 1992 crossing series are presented in tables 5 through 8. Evaluation of families by measuring yield in plots composed of progeny of crosses has been used in an effort to accelerate and give more accurate estimates of the worth of crosses. Family test data collected from the 1990 through 1992 crossing series are presented in Table 9.

Table 1. Summary of selections, advancements and assignments made during 1994 by the Louisiana, "L", Sugarcane Variety Development Programs personnel.

Crossing series	Crosses		Plants surviving transplanting	Over-wintered plants	Advanced to			
	Tested	Selected			1st line	2nd line	Increase	Nursery (Assigned)
	---------- number of clones ----------							
X89	0	192	64003	48715	2779	450	202	45†
X90	258	199	55609	48687	3555	670	288†	
X91	213	165	55625	49535	2690	842†		
X92	134	106	49655	43852	2988†			
X93	213	160	50554†					

† Experimental clones selected and planted into this stage in 1994.

Table 2a. Ratings of experimental clones in first line plant-cane.

Fault or commercial check	Initial no.	Cane yield rating						Clones rating < 6
		≤4	5	6	7	8	9	
	number of clones							
None	2596	238	1446	850	58	2	1	1684
Smut	95	4	47	37	7			51
Rust	1		1					1
CP70-321	114	7	99	8				106

Table 2b. Reasons for dropping first line clones after they passed the initial stage of selection.

Fault†	Initial no.	2nd Stage Faults								3rd Stage Fault	Adv. to 2nd line
		Borer‡	Lodged	Stalk no.	Pith	Smut	Stalk wt.	Tube	Rust	Brix	
	number of clones										
Fault1	1684	205	63	19	10	115	12	10		373	842
Fault2		5	14			12	1		1		

† More than one fault may be given as a reason to drop a clone. The second fault is not necessarily of lesser importance than the first fault listed.
‡ Entries dropped for numerous lateral shoots were categorized as dropped for borer susceptibility.

Table 3. Number and reasons for dropping clones from the 1990 crossing series plant cane second line trial in 1994.

Initial clones	Stage 1	2nd Stage Fault†							Total Ad-vanced
	Stalk no.	Borer‡	Lodged	Smut	Pith	Leaf Scald	Short	2,4-D sus.	
	number of clones								
670	273	48	26	36	6	3	2	1	288

† Entries may have been dropped for more than one reason, thus numbers total more than the 109 clones dropped during the second stage of selection.
‡ Note that entries dropped for numerous lateral shoots were categorized as dropped for borer susceptibility. Some of these may have had leaf scald instead.

Table 4. Yield data summary of 1994 "L" assignments†.

Variety	Female	Male	Sugar yield	Cane yield	Sugar Content	Stalk number	Stalk weight
			lbs/A	tons/A	lbs/ton	no./A	lbs.
CP70-321	CP61-039	CP57-614	9209	35.3	273	29559	1.96
LCP82-089	CP52-068	CP72-370	7735	29.1	265	32982	1.76
L94-403	CP70-330	CP83-644	10946	42.6	262	36867	1.99
L94-404	CP70-321	CP79-318	8520	30.3	279	25183	2.29
L94-405	CP72-1312	CP74-383	9505	35.9	267	35733	1.85
L94-406	CP74-383	CP83-644	8682	32.1	270	28813	2.12
L94-407	CP86-915	CP73-343	14160	53.7	264	37208	2.60
L94-408	LCP85-384	CP80-323	9034	34.7	261	40157	1.65
L94-409	CP78-317	CP73-343	10045	34.9	290	35166	1.86
L94-410	CP83-644	CP74-383	8670	32.7	270	33805	1.86
L94-411	HoCP85-845	CP76-331	9121	34.3	268	31876	2.05
L94-412	CP77-310	LCP81-030	10249	38.1	270	39930	1.79
L94-413	LCP85-384	LCP85-341	6864	33.0	226	41897	1.55
L94-414	LCP85-384	CP77-310	8383	30.9	271	36640	1.60
L94-415	CP78-317	CP73-343	10509	38.4	273	35620	2.01
L94-416	CP65-357	LCP82-089	5517	21.8	214	24616	1.62
L94-417	CP78-317	CP73-343	7084	25.4	279	32557	1.48
L94-418	CP83-644	CP74-383	9800	36.8	272	36640	1.91
L94-419	CP72-356	CP77-407	6157	30.2	211	30061	1.88
L94-420	L84-290	CP83-644	8150	29.0	286	23709	2.36
L94-421	LCP86-450	LCP82-089	12819	45.6	279	36640	2.13
L94-422	LCP81-010	LCP82-089	10585	39.4	268	35847	2.13
L94-423	LCP81-010	LCP82-089	12419	48.0	261	32897	2.69
L94-424	LCP81-010	LCP82-089	13876	52.3	265	37662	2.59
L94-425	LCP85-384	LCP82-089	11800	43.1	269	48211	1.64
L94-426	CP81-332	LCP81-010	10200	38.4	266	32330	2.21
L94-427	CP70-330	CP86-929	9376	34.1	281	25864	2.41
L94-428	LCP81-010	LCP82-089	8450	32.9	259	27792	2.40
L94-429	L84-290	CP83-644	9063	32.8	281	28927	2.18
L94-430	CP86-915	CP75-330	11052	37.0	291	33691	2.03
L94-431	LCP85-384	LCP81-030	11384	44.0	262	29494	2.67
L94-432	LCP81-010	LCP82-089	10410	38.1	274	36414	1.97
L94-433	LCP85-384	LCP82-089	10223	38.2	274	37094	1.95
L94-434	CP79-332	LCP85-336	10209	37.4	272	27225	2.50
L94-435	CP75-361	CP73-343	10668	40.0	271	32557	2.35
L94-436	LCP82-047	89P2	12690	46.7	271	36981	2.44
L94-437	CP86-915	CP75-330	10070	35.9	280	33805	2.01
L94-438	CP65-357	LCP81-030	11893	45.2	267	33351	2.59
L94-439	CP81-332	LCP81-010	9484	39.8	248	38682	2.03
L94-440	LCP86-422	CP80-313	7864	29.5	266	24616	2.32
L94-441	US77-017	LCP85-336	9241	33.8	273	29721	2.03
L94-442	CP76-351	LCP81-030	8940	32.0	285	28246	2.07
L94-443	LCP81-010	LCP82-089	9582	37.7	255	32330	2.14
L94-444	LCP81-010	LCP82-089	12270	50.4	246	31763	2.83
L94-445	CP62-258	LCP85-336	12117	50.4	245	40384	2.29
L94-446	CP65-357	CP75-330	9126	33.7	276	26885	2.40
L94-447	CP52-068	LCP85-371	8184	31.8	266	29040	1.99
Mean			9672	36.6	267	32705	2.07
$LSD_{0.05}$			3516	11.8	36	9137	0.35

† Sugar yield, cane yield and stalk numbers were based on four observations (three plant cane and one first ratoon), sugar content and stalk weight were based on five observations (three plant cane and two first ratoon). The last two plant cane observations were made after numbers were assigned.

Table 5. Advancement summary of progeny from the 1986 through 1989 crossing series that were advanced to assignment. Rank percential is based upon within series advancement percentage of survive to assignment.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
B70-734	CP72-370	89	174	1	14	0	20	0	30	0	42
B70-734	CP73-343	89	233	1	5	0	20	0	30	0	42
B76-719	89P2	89	236	3	26	0	20	0	30	0	42
B76-719	89P3	89	228	1	5	0	20	0	30	0	42
COLD TOL	LCP81-030	86	139	13	87	7	97	2	95	0	42
CP48-103	CP48-103	86	202	0	3	0	11	0	27	0	42
CP48-103	CP62-258	86	1159	31	27	9	39	1	55	0	42
CP48-103	CP62-258	87	339	24	83	3	71	2	54	0	40
CP48-103	CP67-412	88	225	7	30	1	44	0	34	0	44
CP48-103	CP72-1312	88	229	11	45	0	18	0	34	0	44
CP48-103	CP75-1082	89	.	1	.	0	.	0	.	0	.
CP48-103	CP77-310	86	224	9	45	2	50	0	27	0	42
CP48-103	CP77-310	87	459	17	58	5	75	0	27	0	40
CP48-103	CP77-310	88	189	7	36	0	18	0	34	0	44
CP48-103	CP77-310	89	681	18	44	2	46	2	65	0	42
CP48-103	LCP81-030	86	243	46	98	2	43	0	27	0	42
CP48-103	L83-194	86	243	7	28	4	69	2	86	1	90
CP48-103	L84-275	88	92	1	10	0	18	0	34	0	44
CP48-103	P75-1082	89	493	2	5	0	20	0	30	0	42
CP52-068	CP62-258	87	1331	33	44	17	78	7	75	1	82
CP52-068	CP75-308	86	196	6	32	0	11	0	27	0	42
CP52-068	CP75-308	87	108	5	66	0	20	0	27	0	40
CP52-068	LCP81-030	87	821	27	57	5	57	2	55	0	40
CP52-068	LCP81-030	88	751	75	72	6	54	1	68	1	89
CP52-068	LCP85-371	87	245	15	78	4	86	3	92	0	40
CP52-068	LCP85-371	89	471	50	95	7	86	5	92	1	87
CP53-018	CP77-310	87	504	14	48	1	41	1	58	0	40
CP57-614	CP57-614	86	249	20	80	1	25	0	27	0	42
CP57-614	87P1	87	175	0	10	0	20	0	27	0	40
CP61-037	CP67-412	87	205	16	90	3	82	1	73	0	40
CP61-037	CP68-1026	88	217	7	31	1	46	0	34	0	44
CP61-037	CP69-1052	86	174	7	45	2	55	2	91	0	42
CP61-037	CP72-2086	88	81	12	88	3	91	1	93	0	44
CP61-037	CP73-351	86	262	11	49	3	55	0	27	0	42
CP61-037	CP74-1094	88	203	11	48	1	48	1	85	0	44
CP61-037	CP77-310	86	247	4	13	2	42	1	60	0	42
CP61-037	CP78-304	88	425	18	40	2	46	0	34	0	44
CP61-037	CP82-520	86	77	8	91	3	95	1	94	0	42
CP61-037	CP82-520	89	186	1	11	0	20	0	30	0	42
CP61-037	CP84-722	88	186	12	53	0	18	0	34	0	44

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pent'l	no.	Rank pent'l	no.	Rank pent'l	no.	Rank pent'l
CP61-037	LCP81-010	87	244	6	44	0	20	0	27	0	40
CP61-037	LCP82-047	86	217	20	86	3	64	0	27	0	42
CP61-037	LCP82-089	86	243	12	59	2	43	0	27	0	42
CP61-037	LCP84-239	86	199	16	80	5	83	0	27	0	42
CP61-037	L84-275	88	192	15	62	2	65	0	34	0	44
CP61-037	L84-290	88	191	1	5	0	18	0	34	0	44
CP62-258	CP62-258	86	173	0	3	0	11	0	27	0	42
CP62-258	LCP85-336	89	456	39	87	10	93	5	94	1	89
CP62-374	US86-003	87	115	0	10	0	20	0	27	0	40
CP62-374	US86-006	87	84	0	10	0	20	0	27	0	40
CP62-374	US86-016	87	104	0	10	0	20	0	27	0	40
CP65-357	CP48-103	86	227	4	14	2	49	0	27	0	42
CP65-357	CP57-614	86	216	12	64	6	86	0	27	0	42
CP65-357	CP62-258	86	368	17	55	12	91	3	85	1	87
CP65-357	CP62-258	88	1302	79	50	15	69	2	70	0	44
CP65-357	CP62-258	89	479	14	48	2	55	2	71	0	42
CP65-357	CP67-412	87	101	8	91	0	20	0	27	0	40
CP65-357	CP67-412	89	224	19	87	0	20	0	30	0	42
CP65-357	CP69-373	87	406	0	10	0	20	0	27	0	40
CP65-357	CP69-373	88	.	9	.	0	.	0	.	0	.
CP65-357	CP72-2086	86	220	3	13	3	63	1	73	1	94
CP65-357	CP72-2086	88	181	22	81	0	18	0	34	0	44
CP65-357	CP75-1082	88	199	9	42	0	18	0	34	0	44
CP65-357	CP75-330	89	241	14	76	6	96	4	97	1	93
CP65-357	CP76-331	86	236	25	92	8	92	3	92	0	42
CP65-357	CP77-402	86	512	10	17	5	54	3	77	0	42
CP65-357	CP77-402	87	1799	52	61	20	82	11	84	1	61
CP65-357	CP77-402	88	552	30	48	14	87	4	63	0	44
CP65-357	CP77-407	88	230	46	96	5	83	3	94	0	44
CP65-357	CP80-323	86	245	28	93	4	67	2	85	0	42
CP65-357	CP81-325	86	220	5	22	2	51	0	27	0	42
CP65-357	CP82-519	88	95	17	93	0	18	0	34	0	44
CP65-357	CP83-657	86	213	7	36	2	52	2	88	0	42
CP65-357	LCP81-010	89	234	8	56	1	56	1	74	0	42
CP65-357	LCP81-030	86	372	21	64	2	35	0	27	0	42
CP65-357	LCP81-030	87	1003	57	78	15	84	7	79	1	56
CP65-357	LCP81-030	88	683	81	48	15	54	3	61	2	67
CP65-357	LCP81-030	89	1331	31	40	8	61	5	70	1	58
CP65-357	LCP82-089	86	243	8	36	3	59	1	63	0	42
CP65-357	LCP82-089	89	480	27	74	6	80	2	70	1	87
CP65-357	LCP85-336	88	442	14	31	2	45	0	34	0	44

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP65-357	L65-069	86	834	39	56	3	24	0	27	0	42
CP65-357	L83-194	86	225	12	62	0	11	0	27	0	42
CP65-357	L84-290	86	227	5	21	2	49	1	70	1	93
CP65-357	US86-016	87	142	0	10	0	20	0	27	0	40
CP66-346	CP66-346	86	244	5	17	0	11	0	27	0	42
CP67-412	L77-038	88	95	2	18	0	18	0	34	0	44
CP69-373	CP74-2013	88	151	2	12	0	18	0	34	0	44
CP70-1527	CP73-340	88	206	21	73	5	86	1	84	0	44
CP70-1527	CP77-407	88	442	34	61	5	68	1	71	0	44
CP70-300	CP72-355	87	.	1	.	0	.	0	.	0	.
CP70-300	CP72-370	86	238	12	61	5	80	1	66	0	42
CP70-300	CP75-1082	87	256	1	21	0	20	0	27	0	40
CP70-300	LCP81-030	88	454	1	0	1	38	0	34	0	44
CP70-300	LCP81-030	89	229	24	94	1	57	0	30	0	42
CP70-300	L78-063	87	454	7	31	3	62	2	67	1	84
CP70-300	L84-261	87	237	8	54	3	77	2	82	1	89
CP70-300	L84-261	89	486	9	33	0	20	0	30	0	42
CP70-300	US77-010	87	1313	11	24	5	46	2	56	1	82
CP70-321	CP66-346	86	182	13	77	7	94	3	96	1	97
CP70-321	CP73-343	87	144	5	56	1	64	1	78	1	96
CP70-321	CP79-318	89	253	12	68	1	49	1	67	1	92
CP70-321	86P5	86	187	0	3	0	11	0	27	0	42
CP70-330	CP66-346	87	216	5	40	2	71	2	86	0	40
CP70-330	CP67-412	86	106	2	15	0	11	0	27	0	42
CP70-330	CP67-412	87	101	0	10	0	20	0	27	0	40
CP70-330	CP69-1052	87	565	7	29	3	61	2	62	0	40
CP70-330	CP69-1052	88	193	1	5	0	18	0	34	0	44
CP70-330	CP72-355	86	246	20	81	5	79	1	61	0	42
CP70-330	CP73-351	88	240	11	43	2	54	0	34	0	44
CP70-330	CP74-383	86	242	4	14	1	27	0	27	0	42
CP70-330	CP74-383	87	405	4	27	0	20	0	27	0	40
CP70-330	CP76-301	87	248	4	32	0	20	0	27	0	40
CP70-330	CP76-331	88	326	1	1	0	18	0	34	0	44
CP70-330	CP76-331	89	430	11	44	0	20	0	30	0	42
CP70-330	CP77-402	87	230	19	92	2	68	0	27	0	40
CP70-330	CP77-407	87	362	16	65	6	87	3	82	1	86
CP70-330	CP78-321	87	453	12	46	2	55	2	68	1	85
CP70-330	CP79-318	89	476	11	38	0	20	0	30	0	42
CP70-330	CP80-313	86	167	9	63	2	57	0	27	0	42
CP70-330	CP80-329	87	289	15	71	2	64	1	62	0	40
CP70-330	CP80-329	89	303	15	70	0	20	0	30	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP70-330	CP83-644	89	484	22	67	6	80	2	69	1	86
CP70-330	CP85-800	89	218	1	11	0	20	0	30	0	42
CP70-330	CP86-929	89	161	7	65	5	98	1	84	1	98
CP70-330	LCP81-030	86	1150	38	36	9	39	1	55	0	42
CP70-330	LCP81-030	88	657	45	54	6	60	1	69	0	44
CP70-330	LCP82-046	87	74	3	62	0	20	0	27	0	40
CP70-330	LCP82-047	88	408	49	80	5	70	0	34	0	44
CP70-330	LCP82-058	86	248	9	39	1	25	1	59	0	42
CP70-330	LCP82-089	86	202	4	17	1	34	0	27	0	42
CP70-330	LCP83-158	86	230	17	79	6	85	1	70	0	42
CP70-330	LCP85-336	89	493	18	59	0	20	0	30	0	42
CP70-330	LCP86-450	89	248	12	69	1	49	1	68	0	42
CP70-330	L75-002	86	366	16	52	1	24	0	27	0	42
CP70-330	L75-002	89	343	9	44	1	46	0	30	0	42
CP70-330	L77-038	86	234	10	51	0	11	0	27	0	42
CP70-330	L84-290	89	438	22	70	3	65	1	63	0	42
CP71-1086	L65-069	87	964	10	27	1	40	0	27	0	40
CP71-1194	CP62-258	87	940	26	48	14	83	5	76	0	40
CP71-1194	CP72-355	87	914	14	31	3	45	0	27	0	40
CP71-1194	CP77-405	88	243	12	46	1	40	0	34	0	44
CP71-1194	L78-035	88	171	6	33	1	52	0	34	0	44
CP71-1240	CP72-355	87	688	9	29	2	44	0	27	0	40
CP71-1240	CP72-355	88	217	3	13	0	18	0	34	0	44
CP71-357	L78-035	87	243	17	84	7	95	4	96	3	99
CP71-441	CP67-412	88	245	25	73	5	82	0	34	0	44
CP71-441	CP80-323	88	90	17	94	0	18	0	34	0	44
CP71-447	CP76-301	87	650	7	28	2	44	1	56	0	40
CP72- 355	CP67-412	87	216	6	48	1	57	0	27	0	40
CP72-1210	CP73-343	87	241	0	10	0	20	0	27	0	40
CP72-1210	CP74-383	86	249	12	57	0	11	0	27	0	42
CP72-1210	CP77-407	88	217	5	21	0	18	0	34	0	44
CP72-1210	LCP82-047	88	196	19	71	1	49	0	34	0	44
CP72-1210	L75-002	88	203	2	9	0	18	0	34	0	44
CP72-1210	86P3	86	197	2	9	0	11	0	27	0	42
CP72-1312	CP72-1312	86	227	6	25	2	49	0	27	0	42
CP72-1312	CP74-383	89	219	7	53	4	90	2	90	1	95
CP72-1312	CP80-323	89	205	8	60	1	60	0	30	0	42
CP72-1312	LCP82-046	86	240	1	7	0	11	0	27	0	42
CP72-1312	LCP82-047	89	250	10	62	1	49	0	30	0	42
CP72-1312	LCP85-336	89	170	4	40	2	78	1	83	0	42
CP72-1312	86P3	86	247	8	34	0	11	0	27	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP72-1312	86P7	86	163	8	59	5	88	1	79	0	42
CP72-1312	89P2	89	216	4	33	1	58	1	77	0	42
CP72-1312	89P3	89	192	1	11	0	20	0	30	0	42
CP72-2086	CP72-2086	89	492	2	5	0	20	0	30	0	42
CP72-2086	L75-002	88	690	26	37	2	39	0	34	0	44
CP72-355	CP67-412	86	1158	23	17	10	47	2	56	0	42
CP72-355	CP67-412	87	236	21	93	8	97	3	94	1	89
CP72-355	CP72-355	86	224	11	59	2	50	0	27	0	42
CP72-355	CP72-355	87	236	10	64	1	50	1	65	1	89
CP72-355	CP77-310	86	778	50	70	18	81	6	82	4	96
CP72-355	CP77-310	88	132	3	21	2	75	0	34	0	44
CP72-355	CP77-407	89	174	16	89	3	88	0	30	0	42
CP72-355	CP77-414	88	227	5	20	0	18	0	34	0	44
CP72-355	LCP81-030	86	222	12	63	2	51	0	27	0	42
CP72-355	LCP81-030	89	500	28	74	3	64	2	67	0	42
CP72-355	86P1	86	165	6	39	2	58	0	27	0	42
CP72-355	86P2	86	232	29	96	10	96	2	88	2	98
CP72-355	86P2	89	476	17	58	0	20	0	30	0	42
CP72-355	86P3	86	234	11	56	1	30	0	27	0	42
CP72-355	86P4	86	240	21	83	3	60	0	27	0	42
CP72-356	CP77-407	89	157	9	75	3	91	2	95	1	98
CP72-356	LCP85-336	88	230	21	69	1	43	0	34	0	44
CP72-370	CP62-258	86	195	17	82	6	89	1	75	0	42
CP72-370	CP62-258	88	331	10	28	0	18	0	34	0	44
CP72-370	CP62-258	89	381	9	40	0	20	0	30	0	42
CP72-370	CP73-351	86	193	13	74	6	89	0	27	0	42
CP72-370	CP79-348	89	195	6	50	1	61	0	30	0	42
CP72-370	LCP81-010	88	208	9	40	1	47	0	34	0	44
CP72-370	LCP81-030	86	156	13	82	6	94	2	93	0	42
CP72-370	LCP82-047	88	215	41	95	9	93	4	98	1	96
CP72-370	LCP83-149	88	104	9	66	0	18	0	34	0	44
CP72-370	LCP86-393	89	240	14	76	2	68	1	70	0	42
CP72-370	L65-069	86	330	10	30	4	58	2	78	0	42
CP72-370	L65-069	87	239	1	21	0	20	0	27	0	40
CP72-370	L75-002	88	702	21	47	3	58	1	52	0	44
CP72-370	L75-002	89	196	1	11	0	20	0	30	0	42
CP72-370	L84-262	87	203	19	95	4	89	2	88	2	98
CP72-370	US86-003	87	87	0	10	0	20	0	27	0	40
CP73-340	CP57-614	86	226	23	90	6	86	0	27	0	42
CP73-340	CP57-614	88	236	12	46	5	83	1	76	0	44
CP73-340	CP77-310	88	218	14	51	4	78	1	81	0	44

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pent'l	no.	Rank pent'l	no.	Rank pent'l	no.	Rank pent'l
CP73-340	CP80-323	87	250	12	68	2	65	2	79	0	40
CP73-340	86P1	86	220	30	97	15	99	10	99	4	99
CP73-340	86P1	89	250	29	97	0	20	0	30	0	42
CP73-343	CP73-343	88	100	1	9	0	18	0	34	0	44
CP73-343	CP77-402	87	240	0	10	0	20	0	27	0	40
CP73-343	89P3	89	249	4	28	0	20	0	30	0	42
CP73-345	CP48-103	87	239	6	44	1	50	0	27	0	40
CP73-345	CP55-038	87	250	13	71	0	20	0	27	0	40
CP73-345	CP62-258	88	769	86	77	15	81	4	86	0	44
CP73-345	CP72-2086	88	433	54	82	10	84	0	34	0	44
CP73-345	CP74-1094	88	225	10	41	1	44	1	80	0	44
CP73-345	CP75-1091	87	178	2	28	0	20	0	27	0	40
CP73-345	CP76-331	88	183	7	37	1	51	0	34	0	44
CP73-345	CP77-407	86	420	37	83	15	93	8	97	2	95
CP73-345	CP77-407	88	845	18	18	0	18	0	34	0	44
CP73-345	CP78-304	89	207	1	11	0	20	0	30	0	42
CP73-345	CP80-329	88	187	2	10	0	18	0	34	0	44
CP73-345	LCP81-030	86	238	15	69	5	80	0	27	0	42
CP73-345	LCP81-030	89	411	5	24	2	60	0	30	0	42
CP73-345	LCP82-046	88	68	1	15	0	18	0	34	0	44
CP73-345	LCP82-047	88	196	22	77	0	18	0	34	0	44
CP73-345	LCP82-058	88	231	4	15	0	18	0	34	0	44
CP73-345	US77-017	89	228	21	89	3	83	1	75	0	42
CP73-351	CP72-2086	88	193	15	62	2	65	1	86	0	44
CP73-351	CP80-323	88	84	9	76	0	18	0	34	0	44
CP73-351	LCP85-336	88	181	8	41	1	51	0	34	0	44
CP73-351	86P5	86	107	11	91	2	74	0	27	0	42
CP74-1094	LCP83-149	88	193	9	44	0	18	0	34	0	44
CP74-328	CP73-351	86	175	7	45	2	55	1	76	0	42
CP74-328	CP77-405	88	74	1	13	0	18	0	34	0	44
CP74-328	LCP81-030	86	238	29	95	10	96	1	66	0	42
CP74-328	86P4	86	228	0	3	0	11	0	27	0	42
CP74-383	CP48-103	87	448	11	44	1	42	0	27	0	40
CP74-383	CP57-614	87	.	11	.	1	.	0	.	0	.
CP74-383	CP67-412	88	240	7	26	0	18	0	34	0	44
CP74-383	CP72-1210	87	.	6	.	0	.	0	.	0	.
CP74-383	CP72-2086	88	228	33	88	5	84	2	91	0	44
CP74-383	CP74-2013	86	243	14	66	2	43	0	27	0	42
CP74-383	CP74-328	86	240	27	92	2	45	1	64	0	42
CP74-383	CP75-1082	88	484	34	56	1	37	0	34	0	44
CP74-383	CP76-331	86	239	16	74	6	83	0	27	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP74-383	CP77-310	88	241	22	69	4	76	4	97	0	44
CP74-383	CP78-304	88	200	13	53	2	63	0	34	0	44
CP74-383	CP79-318	87	239	8	53	1	50	1	64	0	40
CP74-383	CP80-323	88	424	6	13	1	38	0	34	0	44
CP74-383	CP81-332	87	228	2	25	1	55	1	67	0	40
CP74-383	CP82-537	87	234	14	77	3	78	3	94	0	40
CP74-383	CP83-644	89	435	69	99	11	96	8	98	1	90
CP74-383	LCP81-030	86	574	16	28	1	19	1	43	0	42
CP74-383	LCP81-030	87	460	27	76	14	96	3	77	2	91
CP74-383	LCP81-030	88	207	40	96	8	91	1	84	0	44
CP74-383	LCP81-030	89	452	6	26	0	20	0	30	0	42
CP74-383	LCP82-089	87	231	17	88	3	79	1	66	0	40
CP74-383	LCP85-313	87	223	21	95	8	98	4	97	2	98
CP74-383	LCP85-336	88	456	70	90	18	92	5	92	2	93
CP74-383	LCP86-457	89	154	5	53	1	65	0	30	0	42
CP74-383	L75-002	88	205	1	5	0	18	0	34	0	44
CP74-383	L75-056	88	240	5	18	0	18	0	34	0	44
CP74-383	L83-194	86	245	22	84	8	91	4	95	0	42
CP74-383	L83-194	89	382	7	30	2	62	1	65	0	42
CP74-383	L84-264	87	252	7	48	1	47	1	63	0	40
CP74-383	L84-290	88	202	9	42	0	18	0	34	0	44
CP74-383	87P2	87	212	8	59	0	20	0	27	0	40
CP75-1082	CP57-1082	87	444	3	23	0	20	0	27	0	40
CP75-1082	CP75-1082	87	660	7	21	1	31	0	27	0	40
CP75-1082	CP78-304	88	205	2	9	0	18	0	34	0	44
CP75-1082	CP80-313	89	162	4	41	0	20	0	30	0	42
CP75-1082	CP80-329	88	336	7	18	1	40	0	34	0	44
CP75-1082	87P3	87	209	19	94	5	92	2	87	0	40
CP75-1082	89P4	89	70	3	65	0	20	0	30	0	42
CP75-1091	CP75-1091	87	242	0	10	0	20	0	27	0	40
CP75-1091	86P2	86	236	15	70	1	28	0	27	0	42
CP75-1322	CP77-310	87	1032	42	62	9	68	6	76	3	86
CP75-1632	CP77-405	88	240	6	21	0	18	0	34	0	44
CP75-308	CP69-1052	87	229	4	33	0	20	0	27	0	40
CP75-308	CP70-321	86	230	1	7	0	11	0	27	0	42
CP75-327	CP67-412	87	452	22	69	6	80	3	78	0	40
CP75-327	CP73-351	86	210	8	42	0	11	0	27	0	42
CP75-327	CP77-402	87	1661	67	60	23	81	17	89	1	81
CP75-327	CP80-323	88	210	28	85	4	80	0	34	0	44
CP75-327	LCP85-336	88	443	16	34	6	72	2	80	2	93
CP75-327	LCP85-384	88	462	67	88	7	75	2	77	0	44

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP75-327	L75-056	87	231	8	56	0	20	0	27	0	40
CP75-327	US82-031	87	89	8	94	2	92	1	90	0	40
CP75-330	CP72-356	88	212	4	16	0	18	0	34	0	44
CP75-330	CP75-1082	89	188	6	53	0	20	0	30	0	42
CP75-330	CP77-405	88	214	8	36	0	18	0	34	0	44
CP75-361	CP72-1210	87	234	19	91	0	20	0	27	0	40
CP75-361	CP73-343	89	363	17	65	5	83	3	87	1	69
CP75-361	CP75-1082	88	226	4	16	0	18	0	34	0	44
CP75-361	CP75-330	88	57	6	76	1	77	0	34	0	44
CP75-361	CP77-310	88	193	27	86	2	65	0	34	0	44
CP75-361	CP80-313	88	220	14	51	1	45	0	34	0	44
CP75-361	LCP81-030	86	234	17	79	2	46	1	68	1	91
CP75-361	LCP81-030	87	247	25	96	1	47	1	64	0	40
CP75-361	LCP81-030	89	250	13	73	0	20	0	30	0	42
CP75-361	LCP85-336	88	654	51	62	10	75	2	73	0	44
CP75-361	L75-002	88	211	10	44	2	61	0	34	0	44
CP75-361	L77-038	88	241	9	36	0	18	0	34	0	44
CP75-361	L84-290	88	221	23	75	9	93	3	95	1	94
CP76-301	CP71-441	89	635	20	50	1	42	0	30	0	42
CP76-301	CP76-301	87	226	8	56	1	55	0	27	0	40
CP76-331	CP62-258	86	166	7	49	4	82	0	27	0	42
CP76-331	CP76-331	86	116	6	61	0	11	0	27	0	42
CP76-331	86P3	86	147	0	3	0	11	0	27	0	42
CP76-351	CP77-402	88	188	1	5	0	18	0	34	0	44
CP76-351	CP77-407	88	218	23	76	13	98	5	99	1	95
CP76-351	CP80-329	88	184	1	5	0	18	0	34	0	44
CP76-351	CP83-607	88	184	5	24	2	67	1	87	0	44
CP76-351	CP84-755	88	88	7	64	1	68	0	34	0	44
CP76-351	LCP81-010	88	193	4	18	0	18	0	34	0	44
CP76-351	LCP81-030	89	635	17	46	8	81	4	84	1	84
CP76-351	LCP84-215	88	197	10	46	1	49	0	34	0	44
CP77-310	CP70-330	89	208	4	33	1	60	0	30	0	42
CP77-310	CP77-310	86	252	17	74	5	77	1	58	0	42
CP77-310	CP77-407	88	235	18	61	4	77	0	34	0	44
CP77-310	CP78-304	88	242	25	74	0	18	0	34	0	44
CP77-310	CP84-761	88	414	40	71	7	76	3	89	0	44
CP77-310	LCP81-010	89	241	7	48	0	20	0	30	0	42
CP77-310	LCP81-026	89	230	5	37	0	20	0	30	0	42
CP77-310	LCP81-030	88	210	19	68	1	47	0	34	0	44
CP77-310	LCP81-030	89	226	17	84	5	94	2	89	1	94
CP77-310	LCP82-046	88	230	19	65	2	56	1	78	0	44

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP77-310	LCP85-341	89	196	6	50	0	20	0	30	0	42
CP77-310	89P2	89	232	14	79	2	71	0	30	0	42
CP77-402	CP77-402	86	230	7	30	2	48	0	27	0	42
CP77-402	L65-069	87	944	7	23	2	42	0	27	0	40
CP77-405	CP72-355	86	474	10	20	1	23	0	27	0	42
CP77-405	CP75-1082	88	223	1	2	0	18	0	34	0	44
CP77-405	CP76-331	87	230	5	39	2	68	1	67	1	91
CP77-405	CP77-405	87	149	1	23	0	20	0	27	0	40
CP77-405	CP77-405	89	211	2	20	0	20	0	30	0	42
CP77-405	CP80-323	86	215	8	41	2	52	1	74	0	42
CP77-405	CP81-2149	89	240	2	17	0	20	0	30	0	42
CP77-405	LCP82-089	87	240	13	73	6	94	3	93	0	40
CP77-405	LCP83-151	87	195	7	57	2	74	2	89	0	40
CP77-405	LCP84-257	87	243	7	50	0	20	0	27	0	40
CP77-405	L84-261	87	171	0	10	0	20	0	27	0	40
CP77-405	86P1	86	220	9	47	2	51	0	27	0	42
CP77-405	86P3	86	224	1	7	0	11	0	27	0	42
CP77-405	86P4	86	244	3	10	2	43	1	62	0	42
CP77-405	89P2	89	172	3	29	1	63	0	30	0	42
CP77-405	89P3	89	177	4	38	0	20	0	30	0	42
CP77-407	CP72-1312	89	238	10	63	4	87	2	87	0	42
CP77-407	CP72-370	86	.	25	.	10	.	5	.	2	.
CP77-407	CP75-1082	88	217	15	55	0	18	0	34	0	44
CP77-407	CP77-407	86	220	7	34	0	11	0	27	0	42
CP77-407	86P4	86	253	11	51	4	66	2	82	0	42
CP77-407	87P3	87	194	7	57	4	91	2	90	1	96
CP77-413	85P1	87	254	8	51	2	65	0	27	0	40
CP77-413	85P1	88	192	24	82	1	50	0	34	0	44
CP77-414	CP74-1094	86	241	0	3	0	11	0	27	0	42
CP77-414	LCP81-030	86	198	6	30	3	65	1	75	0	42
CP78-304	CP72-2086	88	214	15	56	6	86	3	96	1	96
CP78-304	LCP82-089	88	241	3	11	0	18	0	34	0	44
CP78-317	CP62-258	87	234	5	38	0	20	0	27	0	40
CP78-317	CP72-355	86	253	0	3	0	11	0	27	0	42
CP78-317	CP72-355	88	139	24	92	2	74	0	34	0	44
CP78-317	CP73-343	86	235	48	99	27	99	7	98	3	99
CP78-317	CP76-301	86	758	2	6	1	22	0	27	0	42
CP78-317	CP76-331	86	249	47	98	9	82	3	83	0	42
CP78-317	CP78-357	86	236	6	24	6	85	1	67	0	42
CP78-317	LCP81-030	86	1537	95	68	37	76	17	87	8	95
CP78-317	LCP81-030	87	308	12	62	3	74	1	62	0	40

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP78-317	LCP85-336	89	367	33	88	6	87	2	82	0	42
CP78-317	L75-056	86	198	13	73	5	84	2	90	1	96
CP78-357	CP72-2086	88	229	27	80	11	96	1	79	0	44
CP78-357	CP73-351	86	197	2	9	0	11	0	27	0	42
CP78-357	CP75-308	87	469	30	79	7	83	4	83	0	40
CP78-357	CP77-407	86	579	20	37	11	74	2	58	1	85
CP78-357	CP77-407	88	183	7	37	2	67	0	34	0	44
CP78-357	CP78-357	86	146	4	27	1	38	0	27	0	42
CP78-357	CP80-323	88	218	16	58	3	73	2	91	0	44
CP78-357	LCP81-010	88	241	47	96	10	93	1	73	0	44
CP78-357	LCP81-030	88	238	10	40	1	41	1	74	0	44
CP78-357	L75-002	87	248	12	68	5	90	3	92	1	88
CP78-357	L84-273	88	91	7	61	0	18	0	34	0	44
CP78-357	86P3	86	237	17	78	6	84	2	87	0	42
CP79-301	CP69-373	86	475	30	69	15	90	3	79	0	42
CP79-311	CP76-301	86	221	8	39	1	31	0	27	0	42
CP79-311	LCP81-030	86	376	14	41	3	41	1	57	0	42
CP79-318	CP62-258	87	1200	22	34	8	63	2	57	0	40
CP79-318	CP67-412	88	231	7	28	2	56	0	34	0	44
CP79-318	CP69-1052	87	462	14	50	0	20	0	27	0	40
CP79-318	CP70-321	86	209	9	51	0	11	0	27	0	42
CP79-318	CP70-321	87	244	6	44	3	77	3	92	0	40
CP79-318	CP72-356	88	105	3	26	0	18	0	34	0	44
CP79-318	CP73-343	87	243	17	84	2	67	2	82	0	40
CP79-318	CP73-343	89	753	2	1	0	20	0	30	0	42
CP79-318	CP74-2013	86	235	6	25	4	70	0	27	0	42
CP79-318	CP75-1082	86	240	7	28	4	69	0	27	0	42
CP79-318	CP77-402	88	226	15	53	0	18	0	34	0	44
CP79-318	CP77-405	88	202	14	55	5	86	0	34	0	44
CP79-318	CP80-323	88	1601	92	49	14	56	3	70	0	44
CP79-318	LCP81-010	89	246	1	5	0	20	0	30	0	42
CP79-318	LCP81-030	86	657	38	66	9	63	4	79	0	42
CP79-318	LCP82-089	86	252	29	94	8	90	2	83	1	88
CP79-318	LCP82-089	89	953	16	29	4	54	2	66	0	42
CP79-318	LCP83-126	86	239	20	82	9	94	2	87	0	42
CP79-318	LCP83-126	89	325	11	56	0	20	0	30	0	42
CP79-318	LCP84-222	88	450	28	51	4	59	0	34	0	44
CP79-318	LCP85-298	88	185	5	24	0	18	0	34	0	44
CP79-318	LCP85-336	88	436	25	49	5	69	0	34	0	44
CP79-318	LCP85-371	87	453	38	93	3	62	2	68	1	85
CP79-318	LCP85-371	89	905	29	53	7	66	4	75	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP79-318	LCP86-457	89	237	10	63	0	20	0	30	0	42
CP79-318	L75-056	87	250	1	21	0	20	0	27	0	40
CP79-318	L84-264	87	705	26	54	1	33	1	45	0	40
CP79-318	L84-290	88	208	3	13	0	18	0	34	0	44
CP79-318	US77-010	87	228	11	68	4	88	0	27	0	40
CP79-318	US77-010	89	494	18	58	1	43	0	30	0	42
CP79-318	US86-004	87	143	0	10	0	20	0	27	0	40
CP79-318	US86-006	87	142	0	10	0	20	0	27	0	40
CP79-318	US86-016	87	109	0	10	0	20	0	27	0	40
CP79-318	86P4	86	237	16	75	3	60	1	67	0	42
CP79-318	87P1	87	162	3	35	0	20	0	27	0	40
CP79-318	89P4	89	238	3	26	0	20	0	30	0	42
CP79-332	CP57-614	88	236	6	21	1	41	0	34	0	44
CP79-332	CP62-258	86	1294	15	28	6	42	2	52	1	65
CP79-332	CP67-412	88	1112	98	80	24	88	2	53	0	44
CP79-332	CP70-321	86	322	0	3	0	11	0	27	0	42
CP79-332	CP72-356	88	231	24	75	7	88	0	34	0	44
CP79-332	CP72-370	88	454	44	71	13	87	3	88	1	89
CP79-332	CP73-343	86	245	5	17	4	67	1	61	0	42
CP79-332	CP74-383	86	232	30	96	4	71	0	27	0	42
CP79-332	CP75-1082	86	237	11	55	3	60	1	67	0	42
CP79-332	CP75-308	86	1102	53	57	18	67	7	80	1	85
CP79-332	CP76-331	86	214	13	67	1	33	0	27	0	42
CP79-332	CP76-331	87	451	17	59	10	91	4	85	0	40
CP79-332	CP77-310	87	464	22	67	7	83	6	95	2	90
CP79-332	CP77-310	88	1493	66	55	14	64	5	54	1	66
CP79-332	CP78-357	88	217	41	94	4	78	1	82	0	44
CP79-332	CP80-352	89	235	10	65	5	93	1	73	0	42
CP79-332	CP84-722	88	234	50	97	10	94	3	93	1	92
CP79-332	CP86-978	87	132	7	72	2	84	1	78	0	40
CP79-332	LCP81-030	86	251	23	86	2	41	0	27	0	42
CP79-332	LCP82-089	86	253	10	45	6	82	2	82	1	88
CP79-332	LCP85-336	89	432	8	33	2	58	2	77	1	90
CP79-332	L78-035	87	204	14	83	0	20	0	27	0	40
CP79-332	L78-063	86	255	14	63	5	76	0	27	0	42
CP79-332	L84-290	88	230	6	23	2	56	1	78	1	93
CP79-332	US82-031	87	201	4	37	1	60	1	74	1	95
CP79-332	US86-003	87	142	0	10	0	20	0	27	0	40
CP79-332	US86-016	87	118	0	10	0	20	0	27	0	40
CP79-348	CP57-614	88	197	6	28	0	18	0	34	0	44
CP79-348	CP70-330	89	212	5	40	0	20	0	30	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP79-348	CP73-343	88	228	36	90	3	71	1	79	0	44
CP79-348	CP79-348	89	236	2	17	0	20	0	30	0	42
CP79-348	CP80-323	88	213	30	87	10	96	3	96	2	98
CP79-348	LCP81-030	86	252	24	87	5	77	0	27	0	42
CP79-348	LCP81-030	88	233	28	80	8	90	3	94	2	98
CP79-348	LCP83-172	87	236	9	59	3	77	2	83	0	40
CP79-348	LCP85-336	89	242	6	41	1	52	0	30	0	42
CP79-348	LCP85-384	88	233	44	94	9	91	2	90	1	92
CP79-348	L75-056	86	248	10	45	2	42	0	27	0	42
CP79-348	L75-056	88	361	26	57	6	76	1	72	0	44
CP80-313	CP69-373	87	384	2	22	1	43	1	61	1	85
CP80-313	CP69-373	88	424	6	13	1	38	0	34	0	44
CP80-313	CP70-321	87	241	2	24	0	20	0	27	0	40
CP80-313	CP70-321	89	639	38	78	5	67	2	66	0	42
CP80-313	CP73-343	88	177	5	25	2	68	0	34	0	44
CP80-313	CP74-328	86	188	17	84	0	11	0	27	0	42
CP80-313	CP76-331	86	204	6	28	1	34	0	27	0	42
CP80-313	CP80-323	87	109	0	10	0	20	0	27	0	40
CP80-313	LCP81-030	86	737	40	65	6	42	1	49	1	68
CP80-313	LCP81-030	87	458	25	73	1	39	0	27	0	40
CP80-313	LCP81-030	88	273	17	51	2	53	0	34	0	44
CP80-313	LCP85-371	87	223	16	86	2	70	1	69	0	40
CP80-313	LCP85-384	89	224	8	58	1	57	1	76	0	42
CP80-313	L77-038	86	205	12	66	4	75	2	89	0	42
CP80-313	86P1	86	128	5	42	1	39	0	27	0	42
CP80-313	86P2	86	251	5	17	1	25	1	59	1	88
CP80-313	86P3	86	138	19	97	1	38	0	27	0	42
CP80-313	86P4	86	247	16	72	4	66	1	60	1	89
CP80-313	86P5	86	166	7	49	1	36	0	27	0	42
CP80-319	CP69-1052	87	182	6	53	0	20	0	27	0	40
CP80-323	CP67-412	88	86	3	33	0	18	0	34	0	44
CP80-323	CP71-459	87	222	2	25	0	20	0	27	0	40
CP80-323	CP73-351	87	232	6	46	2	67	2	84	2	97
CP80-323	CP76-331	87	112	8	85	1	69	0	27	0	40
CP80-323	CP77-402	87	238	0	10	0	20	0	27	0	40
CP80-323	CP77-407	89	179	18	92	2	78	0	30	0	42
CP80-323	LCP82-047	88	226	38	92	2	58	0	34	0	44
CP80-323	LCP84-215	88	145	5	32	0	18	0	34	0	44
CP80-323	L84-276	88	101	4	38	1	63	0	34	0	44
CP80-328	CP62-258	88	236	24	73	3	70	0	34	0	44
CP80-328	CP70-321	88	448	58	85	21	96	6	95	3	97

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP80-328	CP72-355	87	223	7	51	1	56	1	69	0	40
CP80-328	CP72-355	88	404	1	0	0	18	0	34	0	44
CP80-328	CP75-1082	88	205	20	72	0	18	0	34	0	44
CP80-328	CP77-310	88	228	6	23	2	58	0	34	0	44
CP80-328	CP80-356	88	205	18	67	2	62	1	85	0	44
CP80-328	LCP83-149	88	198	25	83	2	63	0	34	0	44
CP80-328	L75-056	88	208	37	93	2	62	1	83	0	44
CP80-328	L77-038	87	150	9	77	0	20	0	27	0	40
CP80-328	L84-290	88	218	39	93	10	95	4	98	0	44
CP80-329	CP80-323	88	208	11	47	0	18	0	34	0	44
CP80-329	LCP81-030	86	168	10	67	2	56	1	78	0	42
CP80-351	CP66-346	87	397	13	53	4	74	1	60	0	40
CP80-351	CP66-346	88	962	29	28	7	53	1	68	0	44
CP80-351	CP76-301	87	520	34	80	1	41	1	57	0	40
CP80-351	LCP81-030	87	936	33	56	4	53	2	58	1	83
CP80-352	CP72-1312	89	202	8	62	2	75	1	79	0	42
CP80-352	CP72-355	87	212	6	48	2	72	1	72	1	94
CP80-352	CP72-355	88	947	71	59	10	66	4	75	0	44
CP80-352	CP73-343	87	235	5	38	1	53	0	27	0	40
CP80-352	CP74-383	89	233	1	5	0	20	0	30	0	42
CP80-352	CP76-301	87	651	10	31	4	61	3	70	1	84
CP80-352	CP77-310	88	426	23	48	4	61	0	34	0	44
CP80-352	CP77-405	88	226	1	2	0	18	0	34	0	44
CP80-352	CP77-407	88	221	16	57	1	45	0	34	0	44
CP80-352	CP80-313	87	228	6	46	1	55	0	27	0	40
CP80-352	CP81-332	88	208	32	90	5	85	2	92	0	44
CP80-352	LCP82-047	89	231	22	90	4	89	2	88	0	42
CP80-352	LCP85-341	89	207	4	33	0	20	0	30	0	42
CP80-352	LCP86-435	89	214	4	33	0	20	0	30	0	42
CP80-352	L84-290	88	188	13	55	4	83	3	96	0	44
CP80-352	89P2	89	233	18	84	0	20	0	30	0	42
CP80-352	89P3	89	185	6	53	0	20	0	30	0	42
CP80-356	CP72-355	86	229	16	76	1	30	0	27	0	42
CP80-356	CP74-2013	87	229	2	25	0	20	0	27	0	40
CP80-356	CP77-402	86	233	10	51	1	30	0	27	0	42
CP80-356	CP78-403	87	246	13	72	3	76	2	80	1	88
CP80-356	CP80-356	88	164	13	63	2	70	0	34	0	44
CP80-356	CP80-356	89	242	7	48	2	68	0	30	0	42
CP81-010	LCP83-133	87	928	19	37	4	53	2	59	0	40
CP81-2062	LCP85-336	89	242	15	80	1	52	0	30	0	42
CP81-2149	89P2	89	252	27	95	6	95	2	86	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pent'l	no.	Rank pent'l	no.	Rank pent'l	no.	Rank pent'l
CP81-316	CP72-355	88	95	12	83	0	18	0	34	0	44
CP81-316	CP75-308	88	231	8	33	0	18	0	34	0	44
CP81-316	CP77-405	88	188	14	58	1	50	0	34	0	44
CP81-316	L78-035	88	98	10	73	0	18	0	34	0	44
CP81-325	CP72-355	86	237	11	55	4	70	1	67	0	42
CP81-325	LCP85-385	87	217	7	52	0	20	0	27	0	40
CP81-329	CP73-351	86	249	38	98	3	57	0	27	0	42
CP81-329	86P3	86	241	0	3	0	11	0	27	0	42
CP81-329	86P3	87	.	6	.	4	.	1	.	0	.
CP81-332	CP57-614	86	221	22	89	4	73	0	27	0	42
CP81-332	CP76-331	86	149	6	45	2	62	0	27	0	42
CP81-332	CP76-331	87	.	13	.	6	.	1	.	0	.
CP81-332	CP80-323	86	178	7	42	1	36	0	27	0	42
CP81-332	LCP81-010	87	428	34	91	13	96	9	98	2	94
CP81-332	LCP81-010	89	291	17	76	9	97	5	97	2	99
CP81-332	LCP83-133	86	155	11	77	2	61	0	27	0	42
CP81-332	US86-013	87	142	0	10	0	20	0	27	0	40
CP81-338	CP76-301	87	2306	102	65	38	87	20	85	10	91
CP81-338	LCP81-030	87	514	29	74	16	97	5	88	2	87
CP82-512	L84-229	86	239	6	24	0	11	0	27	0	42
CP82-513	CP57-614	88	105	2	16	0	18	0	34	0	44
CP82-513	CP73-343	88	221	6	24	0	18	0	34	0	44
CP82-513	LCP81-030	86	249	0	3	0	11	0	27	0	42
CP82-519	L78-063	87	235	17	86	1	53	0	27	0	40
CP82-519	86P2	89	377	13	56	1	45	0	30	0	42
CP82-519	86P6	86	164	15	85	9	97	6	99	0	42
CP82-527	CP80-323	86	248	17	76	5	78	3	91	0	42
CP82-537	CP76-331	86	225	7	32	4	73	1	71	0	42
CP82-537	86P4	86	241	10	47	3	59	1	64	0	42
CP82-550	CP73-343	89	194	16	86	2	76	1	80	0	42
CP82-550	CP77-310	89	238	6	41	0	20	0	30	0	42
CP82-550	CP81-332	88	84	7	65	0	18	0	34	0	44
CP82-550	CP86-969	89	185	2	22	2	77	1	81	0	42
CP82-550	LCP85-298	88	226	19	66	2	58	0	34	0	44
CP82-550	US77-010	87	148	4	47	1	63	0	27	0	40
CP82-550	US82-044	87	99	0	10	0	20	0	27	0	40
CP82-551	CP85-861	89	247	11	67	2	67	1	68	0	42
CP82-551	LCP85-336	89	727	57	85	3	52	0	30	0	42
CP82-552	CP72-1312	86	236	24	90	1	28	0	27	0	42
CP82-559	CP72-355	89	234	19	86	2	70	0	30	0	42
CP82-559	CP80-323	86	249	16	70	6	82	2	83	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP83-149	CP83-149	88	101	1	9	0	18	0	34	0	44
CP83-606	CP57-614	86	224	15	74	5	80	1	72	0	42
CP83-606	LCP82-058	87	247	15	78	0	20	0	27	0	40
CP83-607	CP57-614	88	227	11	45	0	18	0	34	0	44
CP83-607	US77-009	88	90	12	85	0	18	0	34	0	44
CP83-626	CP82-520	86	142	17	95	7	97	2	94	1	97
CP83-626	CP82-520	89	123	1	17	0	20	0	30	0	42
CP83-626	86P6	86	202	12	66	6	88	2	89	1	95
CP83-628	L84-261	86	169	4	23	0	11	0	27	0	42
CP83-628	L84-290	86	191	0	3	0	11	0	27	0	42
CP83-631	LCP82-089	87	215	16	88	2	71	0	27	0	40
CP83-632	L78-035	87	100	5	70	2	90	0	27	0	40
CP83-634	L84-290	86	244	8	36	1	27	1	62	1	90
CP83-644	CP57-614	88	216	25	79	8	91	1	83	0	44
CP83-644	CP74-383	89	368	46	99	9	95	4	93	2	97
CP83-644	CP80-329	88	222	1	5	0	18	0	34	0	44
CP83-644	LCP82-089	88	220	35	91	11	97	1	81	1	94
CP83-644	LCP86-393	89	205	21	93	3	85	1	79	0	42
CP83-644	L84-261	86	172	16	86	7	95	2	91	0	42
CP83-644	L84-261	89	927	36	60	3	47	1	60	0	42
CP84-730	LCP82-047	88	242	67	99	7	87	2	89	0	44
CP85-803	LCP82-047	89	245	1	5	0	20	0	30	0	42
CP85-845	CP76-331	89	216	7	53	3	84	2	91	1	95
CP85-845	LCP85-341	89	221	6	46	4	89	4	98	0	42
CP85-859	CP73-343	89	.	1	.	0	.	0	.	0	.
CP85-860	CP76-331	87	79	0	10	0	20	0	27	0	40
CP85-860	89P1	89	223	14	80	5	94	5	99	0	42
CP85-861	CP85-861	89	216	1	11	0	20	0	30	0	42
CP85-866	CP73-343	89	194	6	50	2	76	0	30	0	42
CP85-866	US82-031	87	166	0	10	0	20	0	27	0	40
CP86-338	LCP81-030	86	.	26	.	9	.	6	.	1	.
CP86-901	CP77-310	89	237	2	17	1	55	1	72	0	42
CP86-915	CP73-343	89	233	12	73	3	82	2	88	1	94
CP86-915	CP75-330	89	221	13	78	2	73	2	90	2	99
CP86-916	89P1	89	226	10	66	2	72	0	30	0	42
CP86-917	LCP82-047	89	254	14	74	1	47	0	30	0	42
CP86-921	CP80-323	89	175	14	85	0	20	0	30	0	42
CP86-927	CP73-343	89	235	10	65	2	70	1	73	0	42
CP86-936	CP70-330	89	177	5	47	0	20	0	30	0	42
CP86-936	CP80-329	89	240	1	5	0	20	0	30	0	42
CP86-939	CP72-370	89	245	5	36	1	52	0	30	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
CP86-946	CP73-343	89	216	4	33	2	74	0	30	0	42
CP86-947	89P1	89	235	1	5	0	20	0	30	0	42
CP86-950	CP80-323	89	228	2	20	0	20	0	30	0	42
CP86-974	CP73-343	89	209	1	11	0	20	0	30	0	42
LCP81-005	CP62-258	87	973	67	83	24	93	11	91	0	40
LCP81-005	CP74-2013	88	218	9	39	2	60	1	81	1	95
LCP81-005	CP75-361	89	248	17	83	1	49	0	30	0	42
LCP81-005	CP84-761	88	223	8	34	0	18	0	34	0	44
LCP81-005	LCP81-030	86	554	18	34	4	38	1	57	1	86
LCP81-005	LCP81-030	87	334	5	31	0	20	0	27	0	40
LCP81-005	LCP81-030	89	475	14	41	3	49	0	30	0	42
LCP81-005	L75-056	87	244	16	81	1	48	0	27	0	40
LCP81-010	CP67-412	87	212	16	89	1	58	1	72	0	40
LCP81-010	CP67-412	89	224	2	20	0	20	0	30	0	42
LCP81-010	CP72-355	86	242	11	54	7	87	4	96	0	42
LCP81-010	CP73-343	87	246	14	75	2	66	2	80	0	40
LCP81-010	CP74-2013	86	240	5	20	0	11	0	27	0	42
LCP81-010	CP76-331	86	227	16	76	13	98	7	98	1	93
LCP81-010	CP76-331	89	619	17	50	1	32	0	30	0	42
LCP81-010	CP77-410	87	249	18	86	1	47	0	27	0	40
LCP81-010	CP78-357	88	232	31	86	7	88	1	76	0	44
LCP81-010	CP82-513	87	146	0	10	0	20	0	27	0	40
LCP81-010	LCP81-030	86	248	22	84	1	25	0	27	0	42
LCP81-010	LCP82-089	86	231	27	94	13	98	5	97	1	91
LCP81-010	LCP82-089	88	614	1	0	0	18	0	34	0	44
LCP81-010	LCP82-089	89	1904	190	92	31	83	14	85	5	88
LCP81-010	LCP85-336	89	494	2	5	0	20	0	30	0	42
LCP81-010	LCP85-341	89	213	25	97	8	99	2	91	0	42
LCP81-010	L75-056	86	249	3	10	2	41	0	27	0	42
LCP81-010	L84-261	87	226	9	60	3	80	3	96	1	92
LCP81-010	US82-044	87	103	2	35	0	20	0	27	0	40
LCP81-010	89P2	89	195	2	22	0	20	0	30	0	42
LCP81-012	CP70-321	86	20	2	89	0	11	0	27	0	42
LCP81-015	CP80-323	88	227	18	63	2	58	0	34	0	44
LCP81-023	CP70-321	87	.	7	.	1	.	1	.	0	.
LCP81-023	L65-069	86	1047	42	45	18	71	3	58	0	42
LCP81-030	CP72-355	89	216	14	82	0	20	0	30	0	42
LCP81-030	CP77-310	88	238	59	98	11	95	2	90	1	91
LCP81-030	LCP81-030	86	206	9	52	4	75	1	74	0	42
LCP81-030	LCP82-089	88	211	1	5	0	18	0	34	0	44
LCP81-030	LCP86-457	89	163	14	87	1	64	0	30	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
LCP81-030	86P3	86	236	0	3	0	11	0	27	0	42
LCP82-033	CP73-343	88	217	19	67	3	73	0	34	0	44
LCP82-033	CP75-1082	88	230	6	23	1	43	1	78	0	44
LCP82-033	CP77-310	87	194	5	46	1	60	1	75	1	96
LCP82-033	CP77-310	88	210	1	5	0	18	0	34	0	44
LCP82-033	CP77-402	88	235	7	28	3	71	1	76	0	44
LCP82-033	CP78-317	89	234	15	81	2	70	0	30	0	42
LCP82-046	CP48-103	87	164	10	78	0	20	0	27	0	40
LCP82-046	CP48-103	89	544	12	37	1	43	0	30	0	42
LCP82-046	CP57-614	87	211	12	75	3	81	2	87	0	40
LCP82-046	CP72-355	87	193	10	71	0	20	0	27	0	40
LCP82-046	CP73-343	88	97	2	18	0	18	0	34	0	44
LCP82-046	CP76-331	87	202	22	97	0	20	0	27	0	40
LCP82-046	CP76-331	89	447	11	41	0	20	0	30	0	42
LCP82-046	LCP81-030	86	242	5	20	1	27	1	63	0	42
LCP82-046	LCP81-030	87	251	5	37	1	47	0	27	0	40
LCP82-046	LCP81-030	88	197	6	28	2	64	1	86	1	96
LCP82-046	LCP81-030	89	565	38	82	5	72	1	61	0	42
LCP82-046	LCP82-046	87	.	2	.	1	.	1	.	0	.
LCP82-046	87P1	87	109	4	58	2	89	0	27	0	40
LCP82-046	87P3	87	203	10	69	2	73	1	73	0	40
LCP82-047	CP69-1052	87	402	22	73	1	43	1	60	0	40
LCP82-047	CP70-321	86	421	13	32	1	23	0	27	0	42
LCP82-047	LCP81-030	89	720	16	37	1	42	0	30	0	42
LCP82-047	LCP82-047	86	210	4	15	0	11	0	27	0	42
LCP82-047	LCP82-047	87	154	3	35	0	20	0	27	0	40
LCP82-047	89P2	89	185	7	60	1	63	1	81	1	97
LCP82-057	CP70-321	87	462	10	39	2	53	0	27	0	40
LCP82-058	CP69-1052	86	200	14	76	4	77	0	27	0	42
LCP82-058	CP76-331	86	166	7	49	3	73	0	27	0	42
LCP82-058	LCP82-058	87	111	2	34	0	20	0	27	0	40
LCP82-073	LCP85-371	87	100	12	98	2	90	2	97	1	99
LCP82-089	LCP81-010	89	1196	125	94	31	97	13	93	2	85
LCP82-089	LCP82-089	87	112	1	25	0	20	0	27	0	40
LCP82-089	86P5	86	153	2	12	2	61	1	81	0	42
LCP82-089	89P4	89	215	11	71	0	20	0	30	0	42
LCP82-094	CP76-331	86	209	64	99	2	53	0	27	0	42
LCP82-094	LCP81-030	86	243	28	94	0	11	0	27	0	42
LCP82-094	LCP83-158	86	240	23	88	2	45	0	27	0	42
LCP82-094	L78-063	86	246	14	65	0	11	0	27	0	42
LCP82-094	86P4	86	243	12	59	4	69	2	86	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
LCP83-119	LCP81-030	86	218	9	47	3	64	1	73	1	94
LCP83-119	86P1	86	242	5	20	0	11	0	27	0	42
LCP83-126	LCP83-126	86	167	11	73	1	36	0	27	0	42
LCP83-133	CP77-310	86	240	5	20	1	28	1	64	0	42
LCP83-135	LCP81-030	86	232	22	87	7	88	2	88	0	42
LCP83-135	LCP83-135	86	232	6	25	2	47	0	27	0	42
LCP83-136	CP57-614	87	239	24	96	0	20	0	27	0	40
LCP83-137	CP57-614	87	252	21	92	4	85	0	27	0	40
LCP83-137	CP80-323	87	233	10	64	4	88	2	84	2	97
LCP83-140	CP76-331	86	246	3	10	2	42	0	27	0	42
LCP83-140	CP77-402	86	239	18	79	8	92	3	92	0	42
LCP83-153	LCP81-030	87	222	27	99	5	92	2	85	1	93
LCP83-154	LCP81-030	86	244	10	47	0	11	0	27	0	42
LCP83-154	LCP81-030	88	97	3	30	0	18	0	34	0	44
LCP83-154	86P4	86	166	0	3	0	11	0	27	0	42
LCP83-163	CP77-402	89	244	3	24	1	52	0	30	0	42
LCP83-165	CP72-355	86	234	6	25	2	46	1	68	0	42
LCP83-165	CP76-331	86	236	9	42	1	28	0	27	0	42
LCP83-165	LCP81-030	86	246	25	90	9	93	1	61	0	42
LCP83-165	LCP83-135	86	242	16	73	8	91	4	96	2	98
LCP83-179	CP80-356	86	227	8	37	3	62	1	70	0	42
LCP83-179	LCP81-030	86	248	28	92	5	78	2	84	0	42
LCP84-200	CP75-1082	87	222	0	10	0	20	0	27	0	40
LCP84-212	87P2	87	256	5	37	3	76	3	91	0	40
LCP84-214	CP80-323	87	79	2	44	0	20	0	27	0	40
LCP84-214	CP80-323	89	226	1	5	0	20	0	30	0	42
LCP84-215	CP80-323	87	234	19	91	1	53	0	27	0	40
LCP84-215	LCP81-030	87	232	17	87	7	96	3	95	1	90
LCP84-215	L75-056	87	109	6	73	0	20	0	27	0	40
LCP84-222	86P6	86	154	7	54	3	75	2	94	0	42
LCP85-307	CP76-331	88	89	2	20	0	18	0	34	0	44
LCP85-307	CP84-772	88	163	11	54	3	78	1	87	1	97
LCP85-307	LCP85-336	89	239	2	17	0	20	0	30	0	42
LCP85-313	LCP85-336	88	231	26	78	12	98	4	97	3	99
LCP85-316	CP67-412	88	237	19	64	5	82	1	75	1	91
LCP85-336	CP72-370	88	229	7	30	0	18	0	34	0	44
LCP85-336	LCP85-336	88	95	1	10	0	18	0	34	0	44
LCP85-336	LCP85-336	89	208	1	11	0	20	0	30	0	42
LCP85-352	CP73-343	88	195	9	43	1	49	0	34	0	44
LCP85-384	CP75-1082	89	469	2	5	1	44	0	30	0	42
LCP85-384	CP76-331	89	212	9	63	1	59	1	78	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
LCP85-384	CP77-310	89	.	27	.	8	.	5	.	1	.
LCP85-384	CP80-313	88	240	36	89	1	41	1	74	0	44
LCP85-384	CP80-323	89	471	9	33	4	70	1	62	1	87
LCP85-384	CP80-329	88	225	48	97	22	99	13	99	5	99
LCP85-384	CP86-924	89	226	1	5	0	20	0	30	0	42
LCP85-384	LCP81-030	89	486	18	59	7	85	2	69	1	86
LCP85-384	LCP82-089	89	935	104	96	17	90	10	93	2	89
LCP85-384	LCP85-336	88	411	61	88	14	90	5	93	1	90
LCP85-384	LCP85-341	89	470	45	91	6	82	3	85	1	88
LCP85-385	LCP85-385	87	98	0	10	0	20	0	27	0	40
LCP86-391	LCP82-046	88	79	6	59	0	18	0	34	0	44
LCP86-391	L78-063	86	206	6	28	0	11	0	27	0	42
LCP86-391	L83-194	86	239	3	12	2	45	1	65	0	42
LCP86-391	L83-194	88	101	1	9	0	18	0	34	0	44
LCP86-393	CP72-370	89	230	2	20	0	20	0	30	0	42
LCP86-393	CP73-343	89	238	2	17	0	20	0	30	0	42
LCP86-412	CP73-343	89	481	14	45	0	20	0	30	0	42
LCP86-422	CP77-407	89	228	22	91	9	99	3	96	0	42
LCP86-422	CP80-313	89	200	24	98	7	98	4	99	1	96
LCP86-429	CP80-313	89	428	8	33	1	45	1	64	0	42
LCP86-450	LCP82-089	89	242	27	96	5	92	4	96	1	93
LCP86-453	CP74-383	89	245	1	5	1	52	0	30	0	42
LCP86-453	CP77-405	89	223	3	26	0	20	0	30	0	42
LCP86-453	CP80-329	89	167	2	24	0	20	0	30	0	42
LCP86-454	LCP82-089	89	430	17	62	4	74	1	64	0	42
LCP86-456	CP75-1082	89	221	6	46	3	83	1	76	0	42
LCP86-456	CP77-310	89	164	3	30	0	20	0	30	0	42
L65-069	CP67-412	87	62	0	10	0	20	0	27	0	40
L65-069	L65-069	86	1252	15	10	6	33	0	27	0	42
L75-002	CP77-310	89	1166	55	68	1	41	0	30	0	42
L75-002	LCP81-010	89	214	1	11	0	20	0	30	0	42
L77-038	CP62-258	86	897	44	59	11	59	1	55	0	42
L77-038	L77-038	86	233	6	25	2	47	1	69	0	42
L78-035	CP62-258	86	199	8	45	0	11	0	27	0	42
L78-035	CP62-258	87	660	11	32	5	64	3	70	2	66
L78-035	LCP82-046	88	225	1	2	0	18	0	34	0	44
L78-035	L78-035	87	236	0	10	0	20	0	27	0	40
L78-063	L78-063	86	186	3	13	0	11	0	27	0	42
L78-063	86P4	86	246	12	59	4	67	2	85	1	89
L78-063	87P1	87	253	8	52	2	65	2	79	0	40
L78-063	87P2	87	198	15	89	3	84	2	89	1	95

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
L78-063	87P2	89	236	3	26	1	55	1	73	0	42
L79-012	CP73-351	86	238	0	3	0	11	0	27	0	42
L79-018	LCP81-026	86	219	5	22	1	32	0	27	0	42
L79-018	L79-018	86	.	70	.	20	.	6	.	1	.
L79-034	L82-107	87	254	9	56	0	20	0	27	0	40
L80-035	CP72-355	87	245	6	42	0	20	0	27	0	40
L80-035	CP77-405	87	182	13	85	3	87	0	27	0	40
L80-035	LCP81-030	86	399	17	51	6	64	4	90	0	42
L80-035	LCP81-030	87	105	0	10	0	20	0	27	0	40
L80-038	CP62-258	87	239	26	97	1	50	0	27	0	40
L80-040	CP62-258	86	1066	26	23	0	11	0	27	0	42
L80-35	L75-002	86	939	46	59	21	81	6	80	2	86
L82-107	CP69-373	87	248	10	60	6	93	2	80	0	40
L82-107	L82-107	87	444	5	28	0	20	0	27	0	40
L83-193	CP80-323	88	231	1	2	0	18	0	34	0	44
L83-193	LCP81-030	86	221	14	69	1	31	1	72	0	42
L83-194	CP57-614	86	218	22	89	1	32	1	73	1	94
L83-194	CP73-351	86	231	6	25	2	48	0	27	0	42
L83-194	CP81-311	89	645	14	37	0	20	0	30	0	42
L83-194	L83-194	86	219	2	8	0	11	0	27	0	42
L84-218	CP74-383	86	200	13	72	4	77	0	27	0	42
L84-218	CP74-383	88	343	3	7	1	39	1	72	1	90
L84-218	L84-273	86	163	8	59	0	11	0	27	0	42
L84-224	CP74-383	86	149	2	12	1	37	0	27	0	42
L84-224	L84-273	86	172	1	8	0	11	0	27	0	42
L84-244	CP83-646	86	195	7	39	2	54	1	75	0	42
L84-244	L84-262	86	232	8	37	4	71	1	69	1	91
L84-253	86P6	86	116	9	80	2	71	0	27	0	42
L84-262	L84-262	86	97	2	20	0	11	0	27	0	42
L84-262	L84-262	87	138	0	10	0	20	0	27	0	40
L84-263	86P7	86	196	7	39	1	35	0	27	0	42
L84-266	CP75-1082	88	230	15	53	1	43	0	34	0	44
L84-275	CP75-1082	88	217	9	39	0	18	0	34	0	44
L84-276	CP48-103	88	228	9	38	1	44	0	34	0	44
L84-276	CP72-355	87	195	8	62	1	60	0	27	0	40
L84-276	LCP81-030	88	224	8	34	0	18	0	34	0	44
L84-288	86P6	86	64	2	32	0	11	0	27	0	42
L84-290	CP83-644	89	704	42	79	10	84	4	83	2	91
L84-290	LCP82-047	89	237	12	71	1	55	0	30	0	42
L84-290	US77-017	89	248	1	5	0	20	0	30	0	42
L84-290	89P2	89	177	1	14	0	20	0	30	0	42

Table 5. Continue.

Female	Male	Series	Survive†	1st Line		2nd Line		Increase		Assignment	
				no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l	no.	Rank pcnt'l
L84-290	89P3	89	237	2	17	0	20	0	30	0	42
L84-290	89P4	89	249	7	47	4	86	2	86	0	42
L85-294	L78-035	87	216	6	48	2	71	1	71	1	93
US74-090	CP78-317	89	237	16	83	3	81	2	87	0	42
US74-090	CP80-323	88	182	16	67	1	51	0	34	0	44
US77-010	LCP82-047	87	239	26	97	11	99	6	98	0	40
US77-017	CP62-258	89	193	5	44	1	62	1	81	0	42
US77-017	CP72-356	88	225	59	99	17	99	1	80	0	44
US77-017	CP75-1082	88	203	26	84	4	81	0	34	0	44
US77-017	CP75-308	88	423	52	82	8	80	2	83	0	44
US77-017	CP77-310	86	868	32	41	10	55	1	56	0	42
US77-017	CP77-310	89	239	29	98	2	69	1	71	0	42
US77-017	CP80-329	88	215	27	83	2	60	0	34	0	44
US77-017	LCP82-047	88	213	18	66	0	18	0	34	0	44
US77-017	LCP85-336	89	520	33	80	4	66	2	66	1	85
US77-017	L65-069	87	243	10	62	1	48	1	64	0	40
US77-017	US77-017	89	249	8	53	3	79	0	30	0	42
US78-026	89P1	89	241	2	17	0	20	0	30	0	42
US80-004	CP70-330	89	194	1	11	0	20	0	30	0	42
US82-010	CP82-513	87	88	10	98	4	99	4	99	0	40
US82-010	US82-044	87	89	6	81	4	98	3	99	0	40
US83-030	CP72-370	87	123	7	75	1	66	0	27	0	40
US83-036	LCP82-046	87	85	0	10	0	20	0	27	0	40
US86-002	CP73-343	89	243	4	28	0	20	0	30	0	42
US86-002	CP73-351	87	103	0	10	0	20	0	27	0	40
US86-002	CP83-659	87	141	0	10	0	20	0	27	0	40
US86-004	CP73-351	87	147	0	10	0	20	0	27	0	40
US86-004	CP79-318	87	109	0	10	0	20	0	27	0	40
US86-004	CP82-520	87	100	0	10	0	20	0	27	0	40
US86-008	CP80-323	87	91	0	10	0	20	0	27	0	40
US86-008	CP81-332	87	89	0	10	0	20	0	27	0	40
US86-009	CP81-332	87	145	0	10	0	20	0	27	0	40
US86-011	CP72-370	87	120	0	10	0	20	0	27	0	40
US86-011	CP73-351	87	77	0	10	0	20	0	27	0	40
US86-014	CP83-637	87	136	0	10	0	20	0	27	0	40
US86-015	CP83-637	87	134	0	10	0	20	0	27	0	40
US86-974	US86-003	87	113	0	10	0	20	0	27	0	40
Total‡			252381	12353		2530		868		200	

† Survive - is the number of clones surviving initial planting; 1st Line - is the first clonal stage; 2nd Line - is the second clonal stage; Increase - is the replicated clonal stage after the 2nd Line stage; Assignment - is the stage after the Increase stage.

‡ Totals may differ from Table 1 since crosses with unknown parenteage were not included.

Table 6. Advancement summary of 1990 crossing series clones that were advanced to the increase stage based upon advancement from survive.

Female	Male	Survive†	1st Line		2nd Line		Increase	
			no.	Rank pcnt'l*	no.	Rank pcnt'l	no.	Rank pcnt'l
CP48-103	L83-194	202	11	47	2	61	1	71
CP61-037	CP67-412	196	1	12	0	17	0	26
CP65-357	CP76-331	683	27	36	6	57	2	57
CP65-357	CP77-407	475	46	76	13	87	2	64
CP65-357	CP82-550	149	10	57	3	78	2	87
CP65-357	CP85-830	219	17	65	6	87	2	80
CP65-357	CP86-933	162	12	62	0	17	0	26
CP65-357	CP87-626	130	23	97	1	53	0	26
CP65-357	CP87-662	237	16	58	0	17	0	26
CP65-357	LCP81-030	584	44	47	10	50	4	54
CP65-357	LCP85-384	194	16	68	4	80	3	91
CP65-357	LCP86-402	242	18	62	9	93	4	93
CP65-357	LCP86-454	185	30	96	9	97	3	92
CP65-357	LCP87-496	216	14	55	0	17	0	26
CP65-357	L88-063	256	19	62	7	87	4	92
CP70-321	LCP82-089	242	16	56	1	42	1	64
CP70-330	CP76-331	248	23	74	6	85	2	77
CP70-330	CP83-644	225	36	95	16	99	7	98
CP70-330	LCP86-402	642	19	29	3	45	1	52
CP70-330	LCP86-454	156	1	16	0	17	0	26
CP70-330	LCP87-023	206	18	70	1	47	0	26
CP72-355	CP77-310	424	2	12	2	45	1	55
CP72-370	CP79-318	251	13	44	1	39	1	59
CP72-370	LCP82-047	232	8	32	3	66	0	26
CP72-370	LCP85-384	405	26	54	10	86	6	91
CP72-370	LCP86-393	225	15	57	4	74	1	66
CP72-370	LCP87-494	243	1	6	0	17	0	26
CP73-345	CP62-258	211	1	12	0	17	0	26
CP73-345	CP77-407	218	11	42	2	57	1	67
CP73-345	CP78-304	489	2	6	0	17	0	26
CP74-383	CP72-370	352	49	92	1	37	0	26
CP74-383	CP73-343	159	1	16	0	17	0	26
CP74-383	CP75-308	240	1	6	0	17	0	26
CP74-383	CP77-310	170	17	78	0	17	0	26
CP74-383	CP79-318	415	49	85	3	52	0	26
CP74-383	CP80-323	247	19	64	10	94	1	60
CP74-383	CP83-644	150	13	70	0	17	0	26
CP74-383	HoCP85-845	246	19	64	5	79	3	85
CP74-383	LCP82-089	240	29	87	0	17	0	26
CP74-383	LCP85-336	244	9	34	0	17	0	26

Table 6. Continue

Female	Male	Survive†	1st Line		2nd Line		Increase	
			no.	Rank pcnt'l*	no.	Rank pcnt'l	no.	Rank pcnt'l
CP74-383	LCP85-376	196	1	12	0	17	0	26
CP74-383	LCP85-384	430	20	41	1	36	0	26
CP74-383	US80-004	152	6	35	1	51	0	26
CP75-1082	90P3	243	5	23	1	42	1	63
CP75-361	CP75-1082	373	33	71	1	36	0	26
CP75-361	CP80-323	168	10	52	3	74	1	73
CP75-361	CP82-550	157	25	95	5	91	2	86
CP75-361	CP87-618	228	18	66	2	57	0	26
CP75-361	LCP82-089	35	1	28	0	17	0	26
CP75-361	LCP85-384	740	114	94	43	97	28	99
CP75-361	LCP86-402	214	30	92	4	75	0	26
CP75-361	US77-010	232	20	69	4	72	2	79
CP75-361	90P3	216	17	66	5	82	1	68
CP76-331	CP77-310	233	1	6	0	17	0	26
CP76-331	HoCP85-845	238	7	28	0	17	0	26
CP76-331	LCP85-384	593	26	40	3	47	2	58
CP76-331	LCP86-454	482	44	73	5	62	4	78
CP76-331	90P3	193	16	69	1	48	1	71
CP76-351	CP77-310	216	29	91	7	91	3	88
CP76-351	CP87-618	209	12	48	5	84	3	89
CP76-351	LCP81-010	208	23	83	0	17	0	26
CP76-351	LCP85-384	237	39	97	7	89	5	95
CP76-351	LCP86-402	238	1	6	0	17	0	26
CP76-351	LCP88-091	242	18	62	1	42	0	26
CP76-351	L88-070	176	13	62	2	64	1	73
CP76-351	US77-010	163	20	88	0	17	0	26
CP77-310	CP75-1082	207	8	35	2	60	0	26
CP77-310	L88-046	38	8	99	0	17	0	26
CP77-405	CP85-803	218	13	52	3	68	2	80
CP77-405	LCP82-089	403	1	1	0	17	0	26
CP77-405	LCP85-336	439	11	24	3	51	1	54
CP77-405	LCP85-384	406	10	24	0	17	0	26
CP77-405	90P1	62	7	84	1	70	0	26
CP77-405	90P4	211	1	12	0	17	0	26
CP77-407	LCP82-089	225	28	89	3	67	1	66
CP77-407	90P1	245	18	60	8	92	6	96
CP78-317	CP76-331	221	23	80	7	90	4	94
CP78-317	CP77-310	248	7	26	1	39	0	26
CP78-317	LCP86-402	223	46	98	14	98	4	94
CP78-317	LCP87-479	236	14	50	7	89	0	26
CP78-317	US77-010	244	20	68	3	66	1	62

Table 6. Continue

Female	Male	Survive†	1st Line		2nd Line		Increase	
			no.	Rank pcnt'l*	no.	Rank pcnt'l	no.	Rank pcnt'l
CP78-357	CP80-323	205	27	91	4	77	3	90
CP78-357	LCP81-010	422	41	76	7	71	4	82
CP78-357	LCP81-030	234	8	32	1	43	1	65
CP79-318	CP62-258	459	1	1	0	17	0	26
CP79-318	LCP81-030	244	13	45	0	17	0	26
CP79-318	US77-010	173	1	16	0	17	0	26
CP79-332	LCP81-030	228	1	6	0	17	0	26
CP79-348	CP73-343	311	5	21	2	50	1	57
CP79-348	LCP81-030	465	1	1	0	17	0	26
CP80-323	LCP82-047	449	2	6	0	17	0	26
CP80-328	L75-056	441	3	18	0	17	0	26
CP80-328	L84-290	631	32	43	4	50	3	69
CP80-329	CP77-310	232	1	6	0	17	0	26
CP80-351	LCP81-030	425	13	30	5	65	1	54
CP80-352	CP81-332	230	1	6	0	17	0	26
CP81-316	CP72-355	142	7	41	4	88	1	75
CP82-537	CP76-331	236	1	6	0	17	0	26
CP82-550	LCP82-089	735	77	80	6	55	3	61
CP83-644	CP57-614	474	42	72	11	82	2	65
CP83-644	CP77-310	453	42	74	1	35	1	53
HoCP85-845	HoCP85-845	243	6	24	2	55	0	26
CP86-915	CP77-310	190	3	21	0	17	0	26
CP86-916	CP76-331	209	34	96	2	60	1	69
CP86-917	LCP81-030	199	1	12	0	17	0	26
CP86-933	CP86-933	151	6	36	0	17	0	26
CP86-974	CP72-370	249	11	40	3	65	2	76
CP86-974	CP79-318	190	10	45	0	17	0	26
CP86-974	LCP85-384	252	7	26	1	39	1	58
CP87-609	CP77-407	218	1	12	0	17	0	26
CP87-625	CP77-405	172	16	74	3	73	0	26
CP87-638	90P2	203	1	12	0	17	0	26
CP87-649	90P2	213	3	20	0	17	0	26
CP87-665	90P2	169	1	16	0	17	0	26
LCP81-005	CP62-258	202	6	29	4	77	1	71
LCP81-005	LCP81-030	247	1	6	0	17	0	26
LCP81-010	CP76-331	234	1	6	0	17	0	26
LCP81-010	HoCP85-845	230	14	53	1	43	0	26
LCP81-015	LCP85-384	481	29	52	9	75	5	83
LCP81-015	LCP86-402	245	8	31	1	42	1	61
LCP81-015	LCP86-454	207	13	54	2	60	0	26
LCP81-015	L88-028	173	5	28	0	17	0	26

Table 6. Continue

Female	Male	Survive†	1st Line		2nd Line		Increase	
			no.	Rank pcnt'l*	no.	Rank pcnt'l	no.	Rank pcnt'l
LCP81-030	CP72-370	817	74	73	14	72	6	75
LCP81-030	LCP82-089	544	97	98	1	35	1	52
LCP81-030	LCP85-376	241	28	84	10	96	5	95
LCP81-030	LCP86-402	291	21	60	1	38	0	26
LCP81-030	LCP86-454	181	26	93	1	48	1	72
LCP81-030	90P1	222	6	25	0	17	0	26
LCP81-030	90P3	247	16	55	2	54	1	60
LCP82-046	LCP81-030	242	16	56	6	86	4	93
LCP82-047	CP69-1052	232	1	6	0	17	0	26
LCP82-089	LCP82-089	197	1	12	0	17	0	26
LCP82-089	86P5	213	11	44	0	17	0	26
LCP84-215	LCP81-030	235	1	6	0	17	0	26
LCP85-336	CP76-331	378	12	30	0	17	0	26
LCP85-336	CP77-407	164	24	93	0	17	0	26
LCP85-336	LCP81-030	369	25	58	4	63	0	26
LCP85-336	LCP85-336	190	2	19	0	17	0	26
LCP85-336	90P3	453	29	54	5	59	4	77
LCP85-336	90P4	190	2	19	0	17	0	26
LCP85-376	CP78-317	405	47	84	4	61	1	56
LCP85-384	CP75-1082	304	13	38	7	81	4	86
LCP85-384	CP80-313	430	33	64	9	80	5	84
LCP85-384	LCP81-010	823	28	32	6	52	2	55
LCP85-384	LCP85-336	1154	68	50	11	59	7	74
LCP85-384	90P4	203	24	85	8	94	3	90
LCP86-393	CP77-310	422	15	33	8	76	4	82
LCP86-408	CP70-321	713	68	75	22	90	9	85
LCP86-408	CP77-310	303	15	42	1	37	0	26
LCP86-408	CP80-323	341	18	45	4	64	0	26
LCP86-408	LCP85-384	750	61	67	8	63	3	60
LCP86-420	LCP81-030	125	7	47	1	54	1	76
LCP86-420	L78-063	309	18	49	4	66	2	74
LCP86-429	CP72-370	278	12	38	0	17	0	26
LCP86-429	CP75-1082	213	12	47	4	76	1	68
LCP86-429	CP76-331	148	1	18	0	17	0	26
LCP86-429	CP77-310	151	16	81	5	92	4	96
LCP86-429	CP77-405	414	22	45	2	46	0	26
LCP86-429	CP78-317	386	38	77	9	83	1	56
LCP86-429	CP85-830	180	28	94	1	49	0	26
LCP86-429	LCP81-010	447	44	77	9	78	1	53
LCP86-429	LCP81-030	372	39	80	8	81	3	77
LCP86-429	LCP85-336	955	73	63	16	71	11	84

Table 6. Continue

Female	Male	Survive†	1st Line		2nd Line		Increase	
			no.	Rank pcnt'l*	no.	Rank pcnt'l	no.	Rank pcnt'l
LCP86-429	LCP85-384	742	67	72	31	96	21	97
LCP86-429	LCP86-395	212	13	53	3	68	2	81
LCP86-429	LCP86-402	193	23	86	3	70	2	83
LCP86-429	LCP87-496	243	25	79	1	42	1	63
LCP86-429	L78-063	357	1	2	0	17	0	26
LCP86-429	L88-063	197	24	87	13	98	7	98
LCP86-496	CP77-407	215	9	37	2	58	0	26
LCP87-017	CP76-331	124	16	90	0	17	0	26
LCP87-017	CP87-667	389	42	83	3	53	0	26
LCP87-017	LCP87-472	252	7	26	1	39	0	26
LCP87-017	US78-026	208	3	20	1	46	1	70
LCP87-023	LCP81-030	239	14	50	0	17	0	26
LCP87-023	90P2	233	6	25	2	56	0	26
LCP87-492	CP77-405	75	8	82	0	17	0	26
LCP87-492	LCP85-384	146	19	90	6	95	2	88
LCP87-494	90P4	243	26	82	10	95	7	97
LCP87-496	CP76-331	522	17	31	0	17	0	26
LCP88-091	LCP88-091	105	2	22	1	59	0	26
L78-063	90P1	245	30	87	6	85	2	78
L82-107	CP69-373	229	9	35	0	17	0	26
L88-030	LCP81-030	248	1	6	0	17	0	26
L88-059	CP75-1082	235	1	6	0	17	0	26
L88-060	LCP87-472	201	10	42	3	69	0	26
L88-069	CP87-662	200	16	67	3	69	0	26
L88-072	90P1	142	18	89	5	93	2	89
US77-017	CP72-356	167	1	16	0	17	0	26
US78-026	90P3	223	9	36	0	17	0	26
US86-002	LCP85-384	180	8	40	1	49	1	72
Total‡		55311	3479		650		288	

† Survive - is the number of clones surviving initial planting; 1st Line - is the first clonal stage; 2nd Line - is the second clonal stage; Increase - is the replicated clonal stage after the 2nd Line stage.

‡ Totals may differ from Table 1 since crosses with unknown parenteage were not included.

* pcnt'l = percentile

Table 7. Advancement summary of the 1991 crossing series clones that were advanced to the second line trials based upon advancement from survive.

Female	Male	Survive†	1st Line		2nd Line	
			no.	Rank pcnt'l	no.	Rank pcnt'l
CP65-357	CP83-644	221	29	93	8	89
CP65-357	HoCP85-845	243	26	89	10	92
CP65-357	LCP81-030	154	23	97	8	95
CP65-357	LCP86-454	237	0	22	0	24
CP65-357	LCP88-079	93	11	92	4	94
CP70-1527	CP73-340	431	38	78	11	79
CP70-321	LCP85-336	234	0	22	0	24
CP70-330	CP87-626	182	0	22	0	24
CP70-330	LCP88-079	226	0	22	0	24
CP70-330	LCP88-091	193	0	22	0	24
CP72-2086	91P4	242	13	62	1	49
CP72-355	CP77-407	246	0	22	0	24
CP72-370	LCP81-030	725	75	88	23	85
CP72-370	L89-098	241	12	60	5	74
CP73-340	CP80-323	183	24	93	12	98
CP73-345	LCP86-454	718	0	22	0	24
CP74-383	CP70-321	251	46	98	6	78
CP74-383	CP70-330	232	11	59	3	62
CP74-383	HoCP85-845	221	13	65	5	76
CP74-383	CP88-769	249	0	22	0	24
CP74-383	LCP81-030	249	11	57	4	66
CP74-383	LCP88-091	450	41	79	10	75
CP74-383	LCP89-109	416	0	22	0	24
CP74-383	L88-028	462	0	22	0	24
CP75-361	CP76-331	321	8	54	2	52
CP75-361	HoCP85-845	458	0	22	0	24
CP75-361	LCP82-089	470	24	61	9	71
CP75-361	LCP86-454	100	0	22	0	24
CP75-361	LCP88-079	244	0	22	0	24
CP75-361	LCP88-091	245	26	89	10	92
CP75-361	L84-290	222	0	22	0	24
CP75-361	L88-063	479	29	66	6	59
CP75-361	L89-120	37	0	22	0	24
CP76-331	CP78-317	72	5	71	1	64
CP76-331	LCP81-010	474	0	22	0	24
CP76-331	LCP87-017	216	0	22	0	24
CP76-331	L89-101	209	0	22	0	24
CP76-331	91P4	209	0	22	0	24
CP76-351	CP70-321	240	16	69	3	59
CP76-351	CP77-407	117	0	22	0	24
CP76-351	CP80-323	90	6	69	1	55
CP76-351	LCP85-336	237	0	22	0	24

Table 7. Continue

Female	Male	Survive†	1st Line		2nd Line	
			no.	Rank pcnt'l	no.	Rank pcnt'l
CP77-310	CP76-331	83	0	22	0	24
CP77-310	CP80-323	247	23	81	10	91
CP77-310	L89-098	202	0	22	0	24
CP77-310	91P4	193	3	46	0	24
CP77-405	HoCP85-845	444	0	22	0	24
CP77-405	LCP82-089	455	0	22	0	24
CP77-405	L88-063	799	38	59	14	68
CP77-405	91P5	223	0	22	0	24
CP78-317	LCP85-336	256	0	22	0	24
CP78-317	LCP86-454	235	24	87	7	81
CP78-357	CP70-321	111	4	50	1	53
CP78-357	LCP81-010	242	6	47	2	51
CP78-357	LCP85-384	495	41	75	22	95
CP78-357	LCP89-109	90	9	85	3	87
CP79-318	CP73-343	202	0	22	0	24
CP79-318	CP75-1082	230	0	22	0	24
CP79-318	CP80-323	102	21	99	10	99
CP79-318	LCP82-089	1669	99	65	31	71
CP79-318	LCP85-384	928	72	73	12	62
CP79-318	LCP86-454	232	20	77	3	62
CP79-318	L75-056	210	0	22	0	24
CP79-318	L89-124	249	0	22	0	24
CP79-318	91P5	203	0	22	0	24
CP79-332	CP76-331	90	0	22	0	24
CP79-348	CP75-308	218	8	52	4	70
CP79-348	HoCP85-845	192	0	22	0	24
CP79-348	LCP88-079	86	6	71	5	97
CP79-348	LCP88-091	249	0	22	0	24
CP80-323	LCP85-384	1130	103	79	14	58
CP80-323	91P5	227	6	48	0	24
CP80-328	L84-290	173	9	62	2	56
CP80-329	CP76-351	67	0	22	0	24
CP80-352	CP81-332	104	0	22	0	24
CP80-352	LCP82-047	148	23	97	0	24
CP80-352	L84-290	224	0	22	0	24
CP82-550	CP77-310	242	15	66	5	74
CP82-550	LCP85-336	941	129	95	49	96
CP83-644	CP70-330	240	18	73	3	59
CP83-644	CP74-383	732	0	22	0	24
CP83-644	HoCP85-845	477	31	68	11	76
CP83-644	LCP82-089	1167	105	78	44	89
CP83-644	LCP86-393	237	0	22	0	24

Table 7. Continue

Female	Male	Survive†	1st Line		2nd Line	
			no.	Rank pcnt'l	no.	Rank pcnt'l
CP83-644	LCP88-091	250	11	57	4	65
CP87-657	91P4	87	0	22	0	24
CP88-715	91P3	223	0	22	0	24
CP89-846	CP77-310	235	9	53	2	52
CP89-874	91P3	96	13	94	1	55
LCP81-005	CP62-258	703	40	64	9	60
LCP81-010	CP72-355	90	6	69	3	87
LCP81-010	CP73-343	878	63	59	13	53
LCP81-010	CP74-2013	80	0	22	0	24
LCP81-010	CP79-348	209	9	55	1	50
LCP81-010	LCP81-030	884	38	58	12	63
LCP81-010	LCP82-089	1065	49	58	16	65
LCP81-010	LCP85-336	477	0	22	0	24
LCP81-010	LCP86-454	938	22	47	8	52
LCP81-010	L75-056	87	0	22	0	24
LCP81-010	L89-136	466	0	22	0	24
LCP81-030	CP76-351	172	0	22	0	24
LCP85-336	91P5	225	0	22	0	24
LCP85-384	CP74-383	970	150	97	62	98
LCP85-384	CP78-317	173	0	22	0	24
LCP85-384	HoCP85-845	96	11	92	3	84
LCP85-384	LCP81-010	233	13	63	6	80
LCP85-384	LCP85-336	885	0	22	0	24
LCP85-384	LCP86-454	78	11	95	3	90
LCP85-384	LCP87-496	454	33	72	8	68
LCP85-384	L88-046	242	9	52	3	58
LCP85-384	L89-120	232	0	22	0	24
LCP85-384	91P5	234	20	76	9	90
LCP86-408	LCP82-089	208	23	90	9	94
LCP86-408	LCP85-384	973	98	86	31	86
LCP86-422	CP77-407	113	13	92	2	69
LCP86-429	CP70-321	249	23	80	6	78
LCP86-429	CP75-361	469	44	82	9	72
LCP86-429	CP77-310	254	25	83	8	84
LCP86-429	CP77-407	98	9	80	3	83
LCP86-429	CP80-323	451	45	85	8	69
LCP86-429	HoCP85-845	240	0	22	0	24
LCP86-429	CP88-718	247	0	22	0	24
LCP86-429	LCP86-454	472	39	75	15	85
LCP86-429	L89-120	246	10	55	4	67
LCP86-429	91P3	250	16	67	5	72
LCP86-454	CP87-626	667	0	22	0	24

Table 7. Continue

Female	Male	Survive†	1st Line		2nd Line	
			no.	Rank pcnt'l	no.	Rank pcnt'l
LCP87-017	CP70-321	473	18	53	10	75
LCP87-017	CP76-331	724	0	22	0	24
LCP87-017	LCP85-384	232	0	22	0	24
LCP87-017	L89-097	175	0	22	0	24
LCP87-017	91P1	248	0	22	0	24
LCP87-023	LCP81-010	248	11	57	3	57
LCP87-472	CP78-317	701	49	71	7	54
LCP87-492	LCP85-384	583	60	88	16	81
LCP87-496	L89-136	632	62	83	15	77
LCP87-496	91P4	101	3	49	0	24
L88-028	LCP81-030	248	0	22	0	24
L88-028	91P4	97	0	22	0	24
L88-030	CP75-1082	66	0	22	0	24
L88-030	CP77-310	241	3	45	1	49
L88-073	CP75-1082	251	0	22	0	24
L88-073	LCP87-472	832	42	60	10	56
L88-075	91P4	238	2	44	2	52
L89-101	CP77-310	212	0	22	0	24
L89-110	CP76-331	245	0	22	0	24
L89-110	LCP85-336	69	0	22	0	24
L89-113	LCP85-384	1105	103	81	47	93
L89-115	CP77-310	113	5	57	0	24
L89-115	LCP85-384	296	0	22	0	24
L89-116	CP76-331	164	0	22	0	24
L89-118	CP78-317	248	20	74	5	73
L89-118	LCP86-454	774	0	22	0	24
L89-121	CP77-407	186	0	22	0	24
L89-134	CP76-331	235	0	22	0	24
L89-134	LCP85-384	230	23	85	13	97
L89-140	91P4	248	8	50	4	66
L89-152	CP76-331	131	4	49	0	24
L89-152	LCP85-384	817	0	22	0	24
L89-163	CP76-331	99	11	90	3	82
L89-163	LCP85-384	1187	81	70	39	86
US78-026	LCP87-017	501	7	46	3	50
US78-026	91P4	188	7	52	0	24
US80-004	LCP85-384	205	17	75	7	88
Total‡		55625	2688		842	

† Survive - is the numberof clones surviving intital planting; 1st Line - is the first clonal stage; 2nd line is the second clonal stage.

‡ Note that totals may differ from Table 1 since this table did not include crosses with unknown parantage.

Table 8. Advancement summary of the 1992 crossing series that were advanced to the 1st line trial based upon percent advancement from survive.

Female	Male	Survive†	1st Line	
		no.	no.	Rank Percentile
CP48-103	CP80-323	236	0	24
CP65-357	CP86-933	111	0	24
CP65-357	L88-063	237	11	58
CP70-330	LCP85-384	704	104	86
CP70-330	LCP87-017	485	42	71
CP72-370	92P9	251	37	88
CP73-340	CP77-310	254	0	24
CP73-345	CP62-258	482	0	24
CP74-383	CP89-805	106	0	24
CP74-383	LCP85-384	231	25	80
CP74-383	92P1	469	9	38
CP75-1082	92P5	927	0	24
CP75-361	L84-290	235	0	24
CP76-331	LCP85-384	1674	271	93
CP76-351	CP73-343	651	0	24
CP76-351	CP77-407	240	11	58
CP76-351	CP83-607	221	0	24
CP76-351	LCP87-017	692	0	24
CP77-310	CP84-761	1304	0	24
CP77-310	92P6	245	11	56
CP77-405	LCP82-089	1541	0	24
CP77-405	L90-200	461	0	24
CP77-407	LCP87-017	859	0	24
CP77-407	92P5	477	0	24
CP77-407	92P6	452	37	69
CP78-317	L90-190	729	117	91
CP78-357	CP73-343	717	31	54
CP78-357	CP76-331	916	64	63
CP78-357	CP77-310	197	10	59
CP78-357	LCP82-089	239	39	94
CP78-357	LCP86-454	250	21	70
CP79-348	LCP85-384	1198	128	81
CP81-332	CP76-331	185	0	24
CP82-550	CP89-855	243	0	24
CP82-550	L90-190	731	90	86
CP83-644	LCP82-089	833	0	24
CP83-644	LCP85-384	1557	235	90
CP83-644	LCP87-017	1076	179	95
CP83-644	LCP88-091	247	37	89
CP83-644	L75-056	697	131	97

Table 8. Continue

Female	Male	Survive† no.	1st Line	
			no.	Rank Percentile
CP87-626	92P6	476	0	24
CP87-658	CP87-658	107	0	24
CP87-658	LCP85-384	110	0	24
CP88-739	CP79-318	430	49	82
CP89-805	CP89-805	235	0	24
CP89-831	LCP82-089	153	18	85
CP89-846	CP76-331	85	0	24
CP89-846	CP77-310	409	29	64
CP89-846	CP88-702	361	0	24
CP89-846	LCP82-089	622	0	24
CP89-846	LCP85-384	746	123	95
CP89-846	L75-056	316	28	74
CP89-884	LCP82-089	236	0	24
CP89-889	LCP85-384	1359	265	98
LCP81-005	CP74-2013	976	0	24
LCP81-010	LCP85-384	489	57	84
LCP81-010	92P6	442	19	54
LCP81-030	LCP87-017	452	35	66
LCP81-030	92P5	111	0	24
LCP81-030	92P6	412	44	79
LCP82-046	LCP81-030	109	0	24
LCP82-089	CP76-331	920	82	72
LCP85-384	92P4	970	104	79
LCP85-384	92P9	439	0	24
LCP86-429	CP77-405	204	0	24
LCP86-429	LCP81-030	672	0	24
LCP86-429	L90-190	73	5	62
LCP86-454	92P4	217	22	76
LCP87-017	CP87-667	464	15	51
LCP87-017	92P1	458	0	24
LCP88-091	CP89-816	107	0	24
LHO83-153	LCP82-089	208	20	74
LHO83-153	92P9	327	0	24
L75-002	LCP87-017	637	64	75
L78-063	92P3	327	0	24
L78-063	92P4	498	36	65
L78-063	92P5	375	0	24
L89-113	92P5	206	28	87
L90-170	CP77-310	251	0	24
L90-178	CP79-318	101	0	24
L90-178	LCP85-384	672	35	60

Table 8. Continue

Female	Male	Survive† no.	1st Line	
			no.	Rank Percentile
L90-190	92P1	216	7	51
L90-191	CP76-331	467	0	24
L90-191	CP87-626	700	0	24
L90-200	92P5	108	0	24
L90-207	LCP85-384	95	9	73
L90-216	CP76-331	453	0	24
L90-216	US80-004	549	36	61
US77-010	92P6	221	10	56
US78-026	92P1	492	40	68
US78-026	92P3	456	0	24
US78-026	92P6	454	12	50
US78-026	92P7	423	3	49
Total†		44756	2835	

† Survive- is the number of clones surviving initial planting; 1st Line - is the first clonal stage.
‡ Total number of clones may differ from Table 1 since this table did not include crosses with unknown parentage.

Table 9. First ratoon family means and rank percentiles of cane yield components from the 1990, 1991 and 1992 crossing series measured in August, 1992 , 1993 and 1994, respectively at the St. Gabriel Research Station.

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l
			kg		no.		kg		cm		mm	
COLD TOL	LCP81-030	90	5.27	62	7.08	65	0.73	50	157	17	24	70
CP48-103	CP69-1052	90	4.56	31	6.68	48	0.68	31	182	80	22	12
CP48-103	CP80-323	92	3.96	6	6.58	13	0.59	7	163	14	21	10
CP48-103	CP83-607	92	3.14	0	4.83	1	0.70	23	154	6	24	76
CP48-103	L83-194	90	3.79	10	6.00	15	0.65	18	169	45	22	17
CP61-037	CP67-412	90	4.59	33	6.43	32	0.69	34	166	37	23	36
CP61-037	CP69-1052	90	4.53	30	6.33	27	0.73	47	160	24	24	68
CP65-357	CP70-321	90	5.90	83	7.25	73	0.81	76	184	83	24	55
CP65-357	CP70-321	91	4.81	96	6.55	86	0.73	92	146	58	25	95
CP65-357	CP70-330	91	3.46	59	5.63	48	0.59	54	138	39	23	65
CP65-357	CP76-331	90	4.91	45	6.39	30	0.77	67	151	13	25	93
CP65-357	CP77-407	90	2.57	2	3.75	0	0.69	33	159	21	23	51
CP65-357	CP77-407	91	3.52	61	6.05	70	0.58	47	146	58	22	32
CP65-357	CP77-407	92	5.52	31	6.60	14	0.82	70	181	49	24	77
CP65-357	CP80-323	90	5.63	77	7.60	82	0.75	55	158	18	25	84
CP65-357	CP82-550	90	6.26	89	7.23	72	0.87	89	177	69	25	90
CP65-357	CP83-644	91	4.54	92	6.75	91	0.67	83	152	72	23	66
CP65-357	CP83-657	90	4.40	25	6.70	49	0.65	19	168	43	22	18
CP65-357	CP85-830	90	5.72	80	6.50	40	0.89	92	175	63	25	93
CP65-357	HoCP85-845	91	3.31	49	5.68	51	0.59	54	148	63	22	40
CP65-357	CP86-933	90	6.53	94	7.53	80	0.87	89	183	82	24	79
CP65-357	CP86-933	92	7.02	80	10.00	92	0.70	26	191	62	22	19
CP65-357	CP87-626	90	4.31	20	7.15	67	0.60	9	158	19	22	20
CP65-357	CP87-657	90	6.25	88	7.23	71	0.83	82	179	73	24	66
CP65-357	CP87-662	90	3.78	9	6.35	28	0.60	9	171	51	21	5
CP65-357	LCP81-030	90	4.98	48	6.53	41	0.76	62	163	33	24	77
CP65-357	LCP81-030	91	4.60	93	6.55	86	0.70	86	156	80	24	81
CP65-357	LCP81-030	92	4.91	12	7.08	26	0.70	26	162	12	23	66
CP65-357	LCP85-384	90	6.14	87	6.95	58	0.89	93	210	99	23	44
CP65-357	LCP86-402	90	5.56	75	6.28	24	0.88	91	185	85	24	79
CP65-357	LCP86-454	90	6.16	87	6.95	59	0.87	89	180	76	25	81
CP65-357	LCP86-454	91	2.76	23	4.78	17	0.57	39	126	15	23	74
CP65-357	LCP87-496	90	5.09	54	6.38	30	0.80	74	185	84	23	51
CP65-357	LCP88-079	91	4.37	89	6.03	69	0.73	93	153	75	25	92
CP65-357	L88-028	90	4.38	23	6.68	48	0.66	21	173	56	22	15
CP65-357	L88-063	90	8.07	98	8.25	93	0.97	98	199	96	25	86
CP65-357	L88-063	92	6.65	72	9.55	88	0.69	18	178	40	22	23
CP70-1527	CP73-340	91	4.34	89	5.65	50	0.78	98	155	79	25	94
CP70-321	LCP82-089	90	3.82	12	5.60	8	0.66	23	173	57	22	16

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pcnt'l	mean	pcnt'l	mean	pcnt'l	mean	pcnt'l	mean	pcnt'l
			kg		no.		kg		cm		mm	
CP70-321	LCP82-089	91	2.58	16	5.18	31	0.50	13	129	20	22	27
CP70-321	LCP82-089	91	3.02	36	4.40	9	0.64	73	156	81	22	44
CP70-321	LCP85-336	91	3.98	79	6.18	74	0.64	75	158	83	23	52
CP70-321	LCP85-384	91	3.71	69	6.93	94	0.54	26	140	46	22	26
CP70-330	CP70-330	91	2.17	8	3.75	4	0.57	43	108	1	26	98
CP70-330	CP76-331	90	5.21	60	7.20	70	0.69	34	174	58	22	22
CP70-330	CP76-331	91	2.04	5	3.75	3	0.55	33	145	56	22	29
CP70-330	CP77-407	90	4.13	18	6.13	20	0.68	30	159	20	23	48
CP70-330	CP83-644	90	4.79	41	7.03	62	0.67	26	159	20	23	41
CP70-330	CP87-626	91	2.68	20	4.38	8	0.61	61	139	42	23	71
CP70-330	LCP82-058	91	3.41	55	5.23	34	0.65	76	143	51	24	82
CP70-330	LCP82-089	92	5.60	34	7.80	42	0.72	32	160	9	24	73
CP70-330	LCP85-384	91	3.98	78	6.95	95	0.57	39	155	78	21	17
CP70-330	LCP85-384	92	5.37	23	6.91	23	0.82	71	202	77	22	39
CP70-330	LCP86-402	90	4.27	20	6.08	18	0.71	41	158	19	24	65
CP70-330	LCP86-454	90	5.56	75	8.65	96	0.64	17	149	10	23	50
CP70-330	LCP87-017	92	5.18	19	5.47	4	0.99	93	206	85	24	84
CP70-330	LCP87-023	90	5.66	78	7.70	85	0.73	50	180	75	22	26
CP70-330	LCP88-079	91	2.86	27	4.50	11	0.58	49	118	5	25	94
CP70-330	LCP88-091	91	2.45	11	4.20	6	0.55	31	126	14	23	72
CP70-330	L90-181	92	5.69	38	6.77	16	0.91	90	208	88	23	61
CP72-2086	91P4	91	4.40	90	5.95	65	0.72	92	169	94	23	65
CP72-355	CP77-310	90	4.50	29	6.30	25	0.71	41	162	30	24	59
CP72-355	CP77-407	91	4.13	84	6.20	74	0.66	81	149	66	23	70
CP72-356	LCP85-336	91	2.66	19	4.68	14	0.57	40	137	35	23	56
CP72-370	CP72-370	90	5.53	74	6.48	37	0.85	87	173	57	25	90
CP72-370	CP79-318	90	4.85	44	5.88	13	0.83	83	179	73	24	74
CP72-370	CP86-916	90	4.84	43	6.05	17	0.80	73	181	78	24	53
CP72-370	LCP81-030	91	4.71	94	6.73	90	0.70	86	152	73	24	83
CP72-370	LCP82-047	90	4.46	27	6.50	39	0.68	32	156	17	24	53
CP72-370	LCP85-384	90	5.19	58	7.98	91	0.66	21	176	68	22	13
CP72-370	LCP86-393	90	6.66	95	7.15	67	0.94	97	200	97	24	76
CP72-370	LCP87-494	90	6.11	87	6.83	53	0.89	92	187	89	25	81
CP72-370	L89-098	91	4.36	89	6.35	79	0.69	85	143	52	25	92
CP72-370	92P10	92	5.76	41	6.70	15	0.86	76	180	46	24	79
CP72-370	92P9	92	6.83	78	7.69	37	0.94	92	217	93	23	63
CP73-340	CP57-614	91	2.87	28	4.65	13	0.62	64	146	58	23	45
CP73-340	CP77-310	92	5.42	25	6.79	17	0.83	73	210	90	22	29
CP73-340	CP80-323	91	3.64	65	6.53	85	0.55	31	127	17	23	59

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
CP73-343	92P4	92	6.25	60	7.98	47	0.79	56	212	91	22	19
CP73-345	CP62-258	90	5.01	49	7.03	62	0.71	42	178	70	23	28
CP73-345	CP62-258	91	2.80	24	5.53	44	0.50	13	137	35	21	16
CP73-345	CP62-258	92	5.84	45	8.70	73	0.67	16	167	19	22	32
CP73-345	CP72-2086	91	3.25	46	5.13	29	0.63	69	141	48	23	68
CP73-345	CP77-407	90	5.30	64	7.63	83	0.70	37	167	42	23	33
CP73-345	CP78-304	90	3.98	14	6.78	51	0.60	10	161	26	22	16
CP73-345	LCP86-454	91	2.81	25	4.80	18	0.59	51	136	32	23	69
CP74-383	CP67-412	90	5.67	78	7.48	79	0.76	60	165	36	24	73
CP74-383	CP70-321	91	3.42	58	5.75	55	0.60	57	141	47	23	60
CP74-383	CP70-330	91	4.25	87	6.35	78	0.67	83	155	77	23	70
CP74-383	CP72-356	91	2.57	16	4.70	15	0.54	27	155	77	21	9
CP74-383	CP72-370	90	4.91	45	6.48	37	0.76	60	170	49	24	62
CP74-383	CP73-343	90	3.65	7	5.50	6	0.66	23	136	2	25	86
CP74-383	CP75-308	90	4.85	44	7.35	76	0.65	21	177	69	22	10
CP74-383	CP77-310	90	4.78	40	6.58	42	0.74	52	169	47	24	59
CP74-383	CP78-304	90	4.66	37	7.67	83	0.61	12	162	31	22	18
CP74-383	CP78-304	90	5.63	76	8.40	95	0.67	28	149	9	24	67
CP74-383	CP79-318	90	3.34	3	5.53	7	0.60	10	147	8	23	35
CP74-383	CP80-323	90	5.16	57	6.50	39	0.78	69	166	38	24	73
CP74-383	CP83-632	91	4.46	91	6.23	75	0.73	95	155	79	24	88
CP74-383	CP83-644	90	4.84	43	6.55	41	0.74	53	182	80	23	35
CP74-383	CP83-644	91	4.03	80	6.28	76	0.63	71	151	70	23	46
CP74-383	HoCP85-845	90	5.52	73	6.43	32	0.86	88	185	86	24	70
CP74-383	HoCP85-845	91	3.39	54	6.05	69	0.56	36	141	49	22	37
CP74-383	CP87-662	90	5.27	62	6.85	53	0.76	62	163	32	24	76
CP74-383	CP88-769	91	3.71	70	5.58	45	0.66	81	156	81	23	55
CP74-383	CP89-805	92	5.88	46	8.50	67	0.71	30	161	11	24	73
CP74-383	LCP81-030	90	4.31	20	6.35	28	0.68	32	163	31	23	37
CP74-383	LCP81-030	91	4.91	97	6.95	95	0.71	89	153	74	24	83
CP74-383	LCP81-030	92	5.73	40	7.13	29	0.81	67	168	21	24	89
CP74-383	LCP82-089	90	4.80	43	7.03	61	0.67	27	177	68	22	16
CP74-383	LCP82-089	91	4.24	87	5.85	60	0.73	93	167	92	23	67
CP74-383	LCP85-336	90	4.75	39	6.48	38	0.73	50	175	63	23	40
CP74-383	LCP85-336	91	2.93	31	5.76	55	0.51	18	140	46	21	14
CP74-383	LCP85-336	92	7.02	81	11.13	96	0.65	12	157	7	22	36
CP74-383	LCP85-376	90	6.93	96	8.25	92	0.85	86	168	44	25	92
CP74-383	LCP85-384	90	4.56	31	6.25	22	0.74	52	185	86	22	26
CP74-383	LCP85-384	92	7.32	88	9.48	86	0.81	65	192	65	23	53

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
CP74-383	LCP87-496	90	4.25	19	6.15	20	0.67	29	169	46	22	26
CP74-383	LCP88-091	91	3.07	37	5.63	48	0.55	30	137	35	22	35
CP74-383	LCP89-109	91	2.25	8	4.98	24	0.44	3	120	7	21	15
CP74-383	L88-028	90	4.47	28	5.70	9	0.77	65	160	23	24	73
CP74-383	L88-028	91	2.54	16	5.38	41	0.47	7	121	10	22	33
CP74-383	US80-004	90	5.28	63	6.75	51	0.77	66	173	57	24	63
CP74-383	92P1	92	6.22	59	8.21	55	0.79	58	223	97	21	12
CP75-1082	90P3	90	5.43	69	6.45	34	0.83	82	170	49	25	88
CP75-1082	92P5	92	5.59	33	5.36	3	1.11	99	204	81	26	98
CP75-361	CP70-321	90	6.33	90	6.98	59	0.89	93	204	97	24	53
CP75-361	CP75-1082	90	3.82	12	4.95	3	0.79	71	167	42	24	78
CP75-361	CP75-1082	92	5.72	39	6.01	6	1.01	95	209	89	24	90
CP75-361	CP76-331	91	3.09	38	5.79	57	0.54	27	134	28	22	44
CP75-361	CP80-323	90	5.71	80	7.20	70	0.80	73	180	77	24	57
CP75-361	CP82-550	90	5.26	61	7.02	61	0.75	56	180	76	23	39
CP75-361	CP85-803	90	5.05	52	6.35	28	0.81	74	189	91	23	50
CP75-361	HoCP85-845	91	3.38	53	5.70	52	0.58	48	140	46	23	52
CP75-361	CP86-933	90	5.10	54	6.58	43	0.77	64	172	53	24	61
CP75-361	CP87-618	90	4.79	42	6.73	50	0.70	40	178	71	22	23
CP75-361	LCP82-089	90	5.30	64	8.40	94	0.64	16	150	11	23	49
CP75-361	LCP82-089	91	3.68	68	6.45	82	0.57	40	155	78	21	18
CP75-361	LCP85-384	90	5.13	55	6.50	39	0.78	68	180	77	23	48
CP75-361	LCP86-402	90	4.99	48	8.20	92	0.58	7	161	27	21	7
CP75-361	LCP87-017	92	6.20	56	7.32	30	0.87	80	208	88	23	52
CP75-361	LCP87-023	90	6.63	95	7.35	76	0.89	94	209	98	23	42
CP75-361	LCP87-023	92	6.51	66	9.70	89	0.69	21	180	46	22	25
CP75-361	LCP88-079	91	2.85	26	4.83	19	0.60	57	145	54	23	52
CP75-361	LCP88-091	91	2.75	23	5.45	42	0.51	17	133	27	22	24
CP75-361	L84-290	91	2.54	15	5.18	30	0.49	11	136	34	21	11
CP75-361	L84-290	92	5.07	15	8.23	56	0.64	11	198	73	20	3
CP75-361	L88-063	91	4.52	91	6.85	93	0.66	80	158	84	23	59
CP75-361	L89-120	91	2.74	22	4.78	17	0.56	37	129	20	23	68
CP75-361	US77-010	90	5.35	68	6.45	34	0.82	80	187	89	24	58
CP75-361	90P3	90	6.01	85	7.15	68	0.84	85	192	94	24	56
CP76-331	CP70-330	91	3.15	42	4.38	8	0.72	91	152	73	24	86
CP76-331	CP77-310	90	3.57	7	6.93	57	0.50	2	144	5	20	1
CP76-331	CP77-310	92	3.45	2	5.35	3	0.63	10	153	5	23	48
CP76-331	CP78-317	91	2.86	28	5.55	44	0.50	12	121	9	23	53
CP76-331	CP81-332	91	2.70	20	4.58	12	0.59	51	164	90	21	12

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
CP76-331	CP83-632	91	4.03	80	5.68	51	0.75	96	161	88	24	82
CP76-331	CP83-657	91	4.17	85	5.35	39	0.79	99	181	97	23	72
CP76-331	HoCP85-845	90	5.09	54	5.93	13	0.84	85	164	35	26	94
CP76-331	CP86-917	91	3.99	79	6.50	84	0.62	67	152	73	22	41
CP76-331	LCP81-010	91	2.95	32	5.10	28	0.58	49	127	16	24	82
CP76-331	LCP85-384	90	4.26	19	6.28	24	0.68	30	172	54	22	21
CP76-331	LCP85-384	92	6.17	55	7.43	31	0.86	76	203	79	23	60
CP76-331	LCP86-454	90	5.01	50	7.23	72	0.71	42	145	5	25	88
CP76-331	LCP87-017	91	2.59	17	4.88	21	0.53	24	111	3	24	87
CP76-331	L89-101	91	1.37	0	3.45	1	0.40	1	100	0	22	26
CP76-331	90P3	90	6.87	96	7.73	87	0.90	94	190	92	25	81
CP76-331	91P4	91	2.49	13	4.40	9	0.56	37	124	11	24	76
CP76-331	91P5	91	2.15	7	4.88	21	0.40	1	104	0	21	13
CP76-351	CP70-321	91	2.82	25	5.70	52	0.49	10	125	13	22	36
CP76-351	CP73-343	92	3.91	3	7.45	32	0.53	3	153	5	21	6
CP76-351	CP77-310	90	4.56	31	6.28	24	0.74	52	167	41	24	59
CP76-351	CP77-407	90	5.34	67	7.13	66	0.75	55	182	80	23	37
CP76-351	CP77-407	91	3.02	35	5.05	26	0.57	43	131	24	23	60
CP76-351	CP77-407	92	5.47	26	6.68	15	0.87	78	201	76	23	58
CP76-351	CP80-323	91	2.86	27	5.60	46	0.52	20	134	29	22	25
CP76-351	CP87-618	90	5.53	74	7.55	81	0.72	45	184	83	22	21
CP76-351	LCP81-010	90	5.22	60	8.30	93	0.64	16	160	22	23	29
CP76-351	CP83-607	92	7.69	92	10.53	94	0.72	34	165	17	23	68
CP76-351	LCP85-336	91	2.07	6	5.08	27	0.41	1	121	9	20	5
CP76-351	LCP85-384	90	4.29	20	7.03	62	0.61	12	184	83	20	2
CP76-351	LCP85-384	92	6.04	52	9.53	87	0.63	9	168	22	22	18
CP76-351	LCP86-402	90	4.40	25	5.35	5	0.83	83	151	12	26	97
CP76-351	LCP87-017	92	5.79	42	7.69	37	0.81	68	203	79	22	41
CP76-351	LCP88-091	90	4.93	46	5.45	5	0.88	90	171	52	25	93
CP76-351	L88-063	91	3.30	48	5.80	58	0.57	44	138	39	23	55
CP76-351	L88-070	90	6.09	85	7.30	75	0.83	81	174	60	25	80
CP76-351	US77-010	90	5.28	63	7.00	60	0.74	53	186	87	22	21
CP77-310	CP75-1082	90	4.40	24	6.08	18	0.73	50	160	24	24	68
CP77-310	CP76-331	91	3.22	44	5.20	33	0.62	63	136	34	24	80
CP77-310	CP80-323	91	4.09	83	6.23	75	0.65	78	147	60	23	71
CP77-310	CP84-761	92	4.54	7	7.03	24	0.70	23	187	59	21	15
CP77-310	L88-046	90	5.50	72	7.23	71	0.74	53	174	59	23	46
CP77-310	L89-098	91	2.34	9	5.08	27	0.44	4	127	17	21	6
CP77-310	91P4	91	3.34	50	5.48	43	0.61	59	135	32	24	76

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
CP77-310	92P6	92	6.69	73	8.59	71	0.82	72	205	84	22	42
CP77-405	CP73-343	90	5.87	82	7.45	78	0.79	72	171	51	24	71
CP77-405	CP85-803	90	8.13	98	9.08	98	0.91	96	164	35	27	98
CP77-405	HoCP85-845	91	2.53	15	4.70	16	0.55	29	145	54	21	18
CP77-405	LCP82-089	90	3.61	7	7.60	83	0.48	1	174	60	19	0
CP77-405	LCP82-089	91	2.78	23	4.48	10	0.61	61	129	20	24	88
CP77-405	LCP82-089	92	5.36	22	7.65	36	0.70	28	167	19	23	56
CP77-405	LCP85-336	90	4.62	34	6.65	45	0.70	37	174	59	22	26
CP77-405	LCP85-384	90	5.32	66	7.90	89	0.69	35	180	77	22	17
CP77-405	L88-063	91	4.12	84	6.90	94	0.60	57	140	46	23	65
CP77-405	L90-200	92	3.93	5	4.83	0	0.76	44	152	3	25	96
CP77-405	90P1	90	5.85	81	7.75	87	0.76	59	181	78	23	38
CP77-405	90P2	90	4.78	40	6.65	46	0.73	48	151	13	25	87
CP77-405	90P4	90	6.55	94	8.50	95	0.76	63	178	71	23	41
CP77-405	91P5	91	3.60	63	5.35	38	0.65	76	123	11	25	97
CP77-407	LCP82-089	90	4.13	17	6.35	28	0.65	19	164	35	22	24
CP77-407	LCP87-017	92	6.00	49	7.08	27	0.80	62	186	57	21	5
CP77-407	90P1	90	4.32	21	6.10	19	0.71	44	183	81	22	20
CP77-407	92P5	92	6.59	69	8.33	60	0.79	57	172	28	24	84
CP77-407	92P6	92	7.60	91	8.43	65	0.89	84	175	33	25	94
CP77-407	92P9	92	5.09	15	8.06	50	0.74	37	185	56	22	26
CP78-304	CP72-2086	91	3.90	76	5.95	64	0.67	82	141	48	24	84
CP78-317	CP76-331	90	3.50	6	5.45	6	0.63	15	164	33	22	19
CP78-317	CP77-310	90	2.05	1	4.50	1	0.46	1	167	40	19	0
CP78-317	CP77-310	91	3.67	67	6.60	88	0.55	32	135	31	23	54
CP78-317	CP85-830	90	4.36	22	5.80	11	0.75	58	176	67	23	46
CP78-317	LCP85-336	91	3.84	75	6.40	80	0.61	62	158	83	22	28
CP78-317	LCP86-402	90	3.78	9	6.83	53	0.56	5	166	39	21	2
CP78-317	LCP86-454	91	3.66	66	5.78	56	0.63	70	151	69	23	55
CP78-317	LCP87-479	90	4.49	28	6.05	17	0.71	43	164	35	23	38
CP78-317	L90-190	92	6.20	57	8.10	51	0.76	48	180	46	23	54
CP78-317	US77-010	90	5.01	51	6.68	48	0.75	57	206	98	21	8
CP78-357	CP70-321	91	4.61	93	6.53	85	0.71	88	165	90	23	69
CP78-357	CP73-343	92	7.22	86	8.25	57	0.88	83	194	69	24	77
CP78-357	CP76-331	92	7.31	88	8.78	74	0.83	73	177	37	24	83
CP78-357	CP77-310	92	6.22	58	8.23	57	0.76	42	171	27	23	71
CP78-357	CP80-323	90	5.30	65	6.45	35	0.82	80	191	93	23	50
CP78-357	CP89-855	92	6.55	69	8.78	75	0.75	42	176	34	23	64
CP78-357	LCP81-010	90	5.01	50	7.70	86	0.65	20	146	6	24	65

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pcnt'l	mean	pcnt'l	mean	pcnt'l	mean	pcnt'l	mean	pcnt'l
			kg		no.		kg		cm		mm	
CP78-357	LCP81-010	91	4.97	98	6.58	87	0.74	95	156	81	24	84
CP78-357	LCP81-030	90	5.60	76	7.41	78	0.76	59	191	94	23	29
CP78-357	LCP82-089	92	6.38	64	8.79	76	0.76	46	202	78	22	23
CP78-357	LCP85-384	91	4.30	87	6.78	92	0.63	71	168	94	22	23
CP78-357	LCP86-454	92	5.48	29	6.88	22	0.80	64	158	8	25	96
CP78-357	LCP89-109	91	4.06	82	5.93	63	0.67	83	168	93	22	31
CP79-318	CP62-258	90	3.67	8	5.55	7	0.66	24	148	8	24	63
CP79-318	CP69-1052	90	6.41	91	7.43	78	0.88	90	178	71	25	89
CP79-318	CP73-343	91	2.04	5	4.33	7	0.46	5	119	7	22	33
CP79-318	CP75-1082	91	2.63	19	4.48	10	0.57	44	110	2	25	97
CP79-318	CP76-301	90	3.37	4	5.68	9	0.60	9	153	14	22	22
CP79-318	CP77-405	91	3.42	57	4.95	23	0.69	85	143	52	24	87
CP79-318	CP80-323	91	3.95	78	6.40	80	0.61	62	138	40	23	71
CP79-318	CP80-323	92	7.52	89	8.55	70	0.87	80	180	46	24	88
CP79-318	LCP81-030	90	4.36	22	6.73	50	0.63	14	149	9	23	41
CP79-318	LCP82-089	91	3.19	43	6.10	72	0.52	20	131	24	22	25
CP79-318	LCP85-336	91	1.94	4	3.63	2	0.49	10	118	5	23	51
CP79-318	LCP85-384	91	3.97	78	5.80	58	0.71	87	150	66	24	85
CP79-318	LCP86-454	91	3.58	63	5.78	56	0.62	67	130	23	24	89
CP79-318	L75-056	91	2.96	33	5.35	39	0.55	30	124	12	23	73
CP79-318	L89-124	91	3.70	69	4.93	22	0.75	97	138	40	26	99
CP79-318	L90-176	92	3.42	1	6.35	10	0.48	0	127	0	16	0
CP79-318	US77-010	90	6.16	88	7.30	75	0.86	88	164	33	26	96
CP79-318	91P5	91	2.99	34	5.05	26	0.59	51	130	22	24	79
CP79-332	CP62-258	90	5.31	65	6.85	54	0.79	70	174	58	24	67
CP79-332	CP69-1052	90	4.21	18	6.40	31	0.66	25	161	26	23	35
CP79-332	CP72-356	91	3.24	46	5.10	28	0.64	72	138	40	24	84
CP79-332	CP76-331	90	4.19	18	6.48	37	0.65	19	155	15	23	43
CP79-332	CP76-331	91	3.04	37	4.98	24	0.61	59	127	17	25	92
CP79-332	CP76-331	92	7.89	95	8.95	80	0.90	87	186	57	24	86
CP79-332	CP78-357	90	5.36	69	7.55	81	0.70	38	189	91	22	11
CP79-332	CP78-357	92	6.01	50	7.78	42	0.77	51	187	58	23	51
CP79-332	LCP81-030	90	4.53	30	6.35	29	0.72	45	142	4	25	92
CP79-348	CP73-343	90	3.89	13	6.50	40	0.61	12	137	2	24	62
CP79-348	CP75-308	91	3.53	62	6.05	69	0.59	50	140	44	23	46
CP79-348	CP76-331	91	4.20	86	5.85	60	0.73	93	149	65	25	93
CP79-348	CP77-407	92	5.63	34	6.23	7	0.89	84	179	42	25	92
CP79-348	CP80-323	90	5.73	80	7.05	63	0.81	75	170	50	25	82
CP79-348	CP80-323	91	3.21	43	5.20	32	0.59	54	134	29	23	66

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
CP79-348	HoCP85-845	91	2.90	30	5.25	35	0.56	34	128	19	23	67
CP79-348	LCP81-030	90	4.41	26	6.65	46	0.66	22	160	24	23	35
CP79-348	LCP81-030	91	3.42	57	5.65	49	0.61	58	145	56	23	57
CP79-348	LCP85-336	91	3.45	59	5.38	41	0.62	65	137	38	24	77
CP79-348	LCP85-384	90	4.65	36	7.20	69	0.66	24	168	44	22	22
CP79-348	LCP85-384	92	6.44	65	8.47	66	0.81	66	204	82	22	34
CP79-348	LCP88-079	91	3.13	41	5.03	25	0.63	68	142	50	23	73
CP79-348	LCP88-091	91	3.35	51	5.17	30	0.62	64	122	10	25	96
CP79-348	L75-056	91	3.21	44	5.23	33	0.62	65	136	33	24	80
CP80-313	L77-038	90	4.69	38	6.45	35	0.71	43	158	19	24	60
CP80-319	CP69-1052	90	5.34	67	6.80	52	0.77	66	187	89	23	30
CP80-323	CP73-351	90	3.82	12	6.43	32	0.59	8	156	16	22	15
CP80-323	CP77-407	91	4.80	95	6.30	77	0.78	98	159	84	25	94
CP80-323	LCP82-047	90	4.64	36	6.80	52	0.68	30	187	90	22	9
CP80-323	LCP85-384	91	3.30	49	5.95	65	0.56	35	137	35	22	44
CP80-323	91P5	91	2.89	29	5.70	52	0.53	25	121	9	23	62
CP80-328	CP70-321	90	7.19	98	8.08	92	0.88	92	189	92	24	71
CP80-328	LCP83-149	90	5.93	83	7.90	90	0.76	58	173	56	24	54
CP80-328	L75-056	90	5.25	61	7.68	84	0.68	31	176	67	22	21
CP80-328	L84-290	90	3.96	14	6.95	58	0.58	7	163	32	21	7
CP80-328	L84-290	91	3.14	41	5.98	67	0.52	21	145	57	21	9
CP80-329	CP76-351	91	2.96	33	5.28	36	0.56	38	127	17	24	77
CP80-329	CP77-310	90	5.07	53	6.33	27	0.79	70	175	64	24	67
CP80-351	LCP81-030	90	3.81	11	5.95	14	0.64	15	153	14	23	44
CP80-352	CP76-301	90	5.48	71	7.13	66	0.76	60	185	86	23	32
CP80-352	CP81-332	90	2.23	1	4.80	2	0.47	1	120	1	22	19
CP80-352	LCP82-047	91	5.56	99	8.45	99	0.67	82	183	99	21	16
CP80-352	L84-290	91	3.09	39	6.00	68	0.51	16	137	35	22	25
CP80-356	CP72-355	92	5.50	30	6.80	18	0.80	61	168	22	24	81
CP81-316	CP72-355	90	3.82	12	5.15	4	0.70	38	141	3	25	91
CP81-332	CP76-331	91	2.92	30	4.83	19	0.62	63	160	85	22	24
CP81-332	CP76-331	92	4.50	7	5.86	5	0.77	50	190	61	22	44
CP82-527	CP80-323	90	5.68	78	7.05	63	0.80	73	170	51	24	74
CP82-537	CP76-331	90	5.03	51	7.23	72	0.68	32	159	20	24	56
CP82-550	CP77-310	91	3.86	75	6.73	90	0.55	32	132	26	23	49
CP82-550	CP89-855	92	4.90	11	8.85	77	0.56	4	173	31	20	3
CP82-550	LCP82-089	90	5.63	76	7.85	89	0.72	45	176	66	23	34
CP82-550	LCP85-336	91	3.09	38	5.63	48	0.56	34	150	66	21	19
CP82-550	L90-190	92	4.92	13	7.18	30	0.70	24	183	53	22	22

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l
			kg		no.		kg		cm		mm	
CP82-559	CP80-323	90	5.13	55	7.78	88	0.62	13	162	30	22	19
CP83-607	US77-009	90	5.20	59	7.70	85	0.69	33	172	54	23	29
CP83-644	CP57-614	90	7.04	97	8.75	97	0.82	80	173	56	24	79
CP83-644	CP70-330	91	4.83	96	6.60	88	0.72	90	147	62	24	87
CP83-644	CP74-383	91	2.64	19	5.48	43	0.49	12	120	7	23	51
CP83-644	CP77-310	90	6.33	91	7.70	85	0.81	77	182	80	24	59
CP83-644	CP78-357	91	4.96	97	7.85	98	0.63	70	154	76	23	50
CP83-644	CP84-722	91	4.49	91	5.98	66	0.75	97	181	98	23	54
CP83-644	HoCP85-845	91	3.25	46	5.63	48	0.57	40	139	42	22	31
CP83-644	LCP81-030	91	3.70	68	5.85	60	0.64	73	168	93	22	21
CP83-644	LCP82-089	91	3.42	57	5.95	65	0.57	42	141	49	22	43
CP83-644	LCP82-089	92	7.54	90	12.70	98	0.59	7	170	25	21	9
CP83-644	LCP85-384	92	7.19	85	8.38	62	0.90	88	218	95	22	42
CP83-644	LCP86-393	91	3.84	75	7.40	97	0.51	19	130	22	22	39
CP83-644	LCP87-017	92	7.07	82	8.90	78	0.82	69	192	65	23	57
CP83-644	LCP88-091	91	3.38	53	5.93	63	0.57	42	128	18	24	75
CP83-644	LCP88-091	92	6.87	80	8.78	75	0.80	60	170	26	24	86
CP83-644	L75-056	92	6.60	71	8.40	64	0.78	53	182	51	23	62
CP84-722	CP83-632	91	2.74	22	4.43	9	0.62	65	160	85	22	23
CP84-722	CP83-657	91	3.84	74	5.88	62	0.65	77	152	72	23	72
CP84-730	CP80-313	91	3.13	40	5.58	45	0.56	38	131	24	23	64
CP85-800	CP72-370	91	2.35	10	3.45	1	0.66	80	151	71	23	70
CP85-803	CP77-407	90	6.48	93	7.68	84	0.84	84	169	47	25	90
CP85-829	CP70-330	91	2.03	5	3.50	2	0.58	49	165	90	21	10
CP85-830	CP88-769	91	2.09	6	4.45	10	0.47	7	148	63	20	2
HoCP85-845	CP70-330	91	1.74	2	3.45	1	0.51	15	140	43	21	15
HoCP85-845	HoCP85-845	90	5.19	59	6.30	26	0.83	82	159	22	26	95
CP85-861	CP85-830	91	2.52	14	4.68	14	0.55	29	151	69	21	19
CP86-429	CP85-830	90	2.30	1	4.60	1	0.50	3	114	0	24	60
CP86-915	CP77-310	90	5.03	52	6.03	16	0.82	80	167	42	25	89
CP86-915	CP77-310	92	5.71	38	8.18	52	0.69	21	157	7	23	71
CP86-916	CP76-331	90	5.55	74	7.20	70	0.76	63	161	27	25	83
CP86-916	CP83-632	91	2.94	31	4.05	5	0.71	90	158	83	24	81
CP86-916	CP86-916	90	3.37	4	5.85	12	0.56	5	127	1	24	63
CP86-916	LCP84-222	91	1.58	1	3.10	0	0.50	14	142	50	21	11
CP86-917	LCP81-030	90	3.42	5	4.88	2	0.67	26	143	4	24	68
CP86-933	CP86-933	90	4.00	15	6.90	55	0.58	7	144	5	23	27
CP86-955	LCP82-089	91	4.68	94	6.68	89	0.71	89	177	96	23	46
CP86-974	CP72-370	90	5.52	73	6.45	34	0.85	87	167	40	26	95

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l
			kg		no.		kg		cm		mm	
CP86-974	CP79-318	90	3.80	10	5.35	5	0.73	48	172	52	23	42
CP86-974	CP86-901	91	4.30	88	6.98	96	0.62	67	161	87	22	33
CP86-974	LCP85-384	90	4.68	38	6.30	25	0.73	51	176	66	23	40
CP86-977	CP57-614	91	4.05	82	5.53	43	0.72	91	181	98	22	39
CP87-609	CP77-407	90	4.65	37	6.43	32	0.70	40	166	39	23	38
CP87-625	CP77-405	90	6.52	93	7.25	74	0.90	94	186	88	25	86
CP87-626	LCP82-089	91	3.30	48	5.25	35	0.61	59	166	92	21	18
CP87-626	92P6	92	5.50	30	7.73	39	0.72	32	178	40	22	37
CP87-638	90P2	90	5.64	77	6.93	57	0.82	79	195	95	23	44
CP87-649	LCP81-030	90	4.71	38	5.93	14	0.77	65	166	38	24	68
CP87-649	90P2	90	5.78	81	6.03	16	0.96	98	179	73	26	96
CP87-652	LCP82-089	91	3.67	67	5.60	46	0.65	77	163	89	22	41
CP87-652	LCP85-384	91	4.58	92	7.60	98	0.59	55	175	96	21	7
CP87-657	91P4	91	3.77	73	6.13	73	0.61	61	145	56	23	55
CP87-658	CP87-658	92	5.14	18	8.78	74	0.60	8	161	10	22	21
CP87-658	LCP85-384	92	5.31	20	9.58	88	0.55	3	151	2	21	11
CP87-665	90P2	90	4.99	49	6.35	28	0.79	72	177	70	24	63
CP88-702	LCP86-454	91	5.32	98	6.88	93	0.77	98	161	87	24	89
CP88-715	91P3	91	2.46	12	4.20	6	0.59	50	132	25	24	77
CP88-725	CP78-317	91	2.52	14	4.78	17	0.54	25	147	62	22	23
CP88-725	CP79-348	91	2.12	7	4.15	6	0.52	21	145	57	21	12
CP88-739	CP79-318	92	7.25	87	10.40	92	0.70	26	193	67	21	11
CP88-739	LCP82-089	92	5.68	37	8.50	67	0.67	16	165	17	22	40
CP88-739	LCP85-384	92	5.83	44	8.30	59	0.71	30	199	75	21	8
CP88-748	CP85-830	91	3.60	64	5.83	59	0.62	64	165	91	22	22
CP88-754	CP77-310	91	4.77	95	6.35	78	0.73	95	150	68	25	90
CP88-769	LCP82-089	91	3.56	62	5.73	54	0.63	68	157	82	22	34
CP88-781	CP76-331	91	2.41	10	4.50	11	0.54	26	151	71	21	16
CP88-781	CP88-769	91	1.42	0	3.13	0	0.45	5	139	42	20	5
CP88-781	LCP82-089	91	2.61	18	5.65	49	0.43	3	137	38	17	0
CP88-781	LCP85-384	91	1.88	3	3.90	5	0.51	16	150	68	21	6
CP89-805	CP89-805	92	3.93	4	4.95	2	0.84	75	181	50	24	74
CP89-805	92P3	92	6.82	77	8.21	54	0.90	86	223	98	22	31
CP89-825	CP89-825	92	6.03	51	7.83	43	0.77	50	182	51	23	59
CP89-831	LCP82-089	92	6.32	62	7.09	28	0.91	89	218	94	23	55
CP89-846	CP77-310	91	3.88	76	6.25	75	0.63	68	160	85	22	34
CP89-846	CP77-310	92	5.84	46	8.28	58	0.72	35	202	76	21	13
CP89-846	CP88-702	92	9.98	99	14.75	99	0.75	41	188	60	22	36
CP89-846	LCP82-089	92	5.55	32	8.38	61	0.66	13	169	23	22	30

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
CP89-846	LCP85-384	92	7.78	94	9.95	91	0.78	54	198	72	22	38
CP89-846	L75-056	92	6.14	54	8.55	69	0.72	34	184	55	22	30
CP89-874	91P3	91	3.72	71	6.00	67	0.61	62	145	57	23	62
CP89-884	LCP82-089	92	5.40	24	7.90	45	0.69	19	174	32	22	26
CP89-889	LCP85-384	92	6.80	76	9.73	90	0.74	38	196	71	21	15
LCP81-005	CP62-258	90	6.45	92	7.75	87	0.84	84	179	74	24	75
LCP81-005	CP62-258	91	4.04	81	6.13	73	0.66	78	159	84	23	50
LCP81-005	CP74-2013	92	5.80	43	7.60	35	0.76	47	178	40	23	65
LCP81-005	LCP81-030	90	4.58	32	6.20	21	0.72	46	167	40	23	45
LCP81-009	LCP81-030	90	4.12	17	5.95	14	0.70	38	170	50	23	33
LCP81-010	CP72-355	90	6.25	89	7.50	79	0.82	78	193	95	23	38
LCP81-010	CP72-355	91	4.83	96	6.93	94	0.71	87	134	28	26	98
LCP81-010	CP73-343	91	3.14	41	5.40	41	0.58	48	137	37	23	59
LCP81-010	CP74-2013	91	3.19	42	4.33	7	0.74	96	134	29	26	99
LCP81-010	CP76-331	90	5.81	81	7.13	66	0.81	77	174	60	24	77
LCP81-010	CP79-348	91	4.02	80	5.40	42	0.74	96	145	55	25	95
LCP81-010	CP82-513	91	5.38	98	5.95	65	0.88	99	183	99	25	91
LCP81-010	HoCP85-845	90	5.38	69	6.90	55	0.78	69	162	30	25	86
LCP81-010	LCP81-030	91	4.11	83	5.83	59	0.71	87	147	61	25	93
LCP81-010	LCP82-089	91	3.83	74	6.53	85	0.59	53	137	37	23	64
LCP81-010	LCP85-336	91	2.95	32	5.10	28	0.58	45	126	15	24	79
LCP81-010	LCP85-341	91	3.35	51	5.93	64	0.56	34	137	38	22	41
LCP81-010	LCP85-384	92	7.73	93	7.84	44	1.03	96	224	99	24	75
LCP81-010	LCP86-454	91	3.32	50	5.73	54	0.59	51	126	15	24	85
LCP81-010	L75-056	91	3.43	58	4.83	19	0.67	82	138	40	25	91
LCP81-010	L89-136	91	3.90	77	5.35	39	0.73	92	141	49	25	96
LCP81-010	92P6	92	7.07	83	6.84	20	1.06	98	203	80	26	97
LCP81-015	LCP85-384	90	5.46	70	8.30	93	0.66	25	176	67	22	14
LCP81-015	LCP86-402	90	4.59	33	6.65	46	0.70	37	160	24	23	49
LCP81-015	LCP86-454	90	3.97	14	6.25	22	0.64	17	172	54	22	14
LCP81-015	L88-028	90	4.07	16	6.05	17	0.67	25	162	29	23	30
LCP81-015	L88-063	90	3.51	6	5.55	7	0.63	14	170	49	22	11
LCP81-015	L88-075	90	4.42	26	5.95	15	0.73	48	179	72	23	32
LCP81-030	CP72-370	90	6.11	86	7.50	80	0.82	78	176	66	24	75
LCP81-030	CP76-351	91	1.86	3	3.98	5	0.47	7	119	6	22	42
LCP81-030	LCP82-089	90	4.60	34	6.45	33	0.70	39	186	88	22	12
LCP81-030	LCP85-376	90	3.99	15	5.25	4	0.73	48	174	62	23	40
LCP81-030	LCP86-393	90	5.14	56	5.78	11	0.91	95	188	90	25	83
LCP81-030	LCP86-402	90	5.51	72	6.48	37	0.85	85	183	82	24	72

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
LCP81-030	LCP86-454	90	4.62	35	6.38	30	0.73	51	151	12	25	84
LCP81-030	LCP86-457	91	4.08	82	6.48	83	0.64	72	132	25	25	91
LCP81-030	LCP87-017	92	7.09	84	8.08	50	0.88	81	177	37	25	94
LCP81-030	90P1	90	5.01	50	6.98	59	0.74	52	199	96	22	11
LCP81-030	90P3	90	6.27	89	6.45	34	1.00	99	175	64	27	99
LCP81-030	92P6	92	6.20	57	6.28	9	1.00	94	208	87	24	91
LCP82-033	CP72-355	90	5.35	68	6.58	42	0.81	77	175	64	24	77
LCP82-046	LCP81-030	90	5.48	70	6.85	54	0.82	80	174	60	25	81
LCP82-046	LCP81-030	92	5.48	28	7.76	41	0.71	31	179	42	22	33
LCP82-047	CP69-1052	90	6.03	85	7.33	75	0.78	69	178	70	23	47
LCP82-089	CP76-331	92	7.73	92	9.40	85	0.84	74	164	15	25	93
LCP82-089	LCP82-089	90	4.76	40	8.70	97	0.55	4	138	3	23	31
LCP82-089	86P5	90	4.50	29	7.90	90	0.57	6	152	14	22	14
LCP82-094	CP76-331	92	5.63	35	6.40	12	0.88	82	164	15	26	99
LCP82-094	LCP81-030	92	5.76	42	6.83	19	0.87	79	196	70	23	67
LCP82-089	CP83-657	91	1.71	1	3.80	4	0.45	4	138	39	20	3
LCP83-153	LCP81-030	90	3.49	5	5.05	3	0.70	37	147	6	25	87
LCP84-214	CP84-722	91	3.67	67	5.28	36	0.69	85	183	98	22	31
LCP84-215	LCP81-030	90	4.31	21	6.50	39	0.65	20	172	53	22	12
LCP84-222	CP86-901	91	3.65	66	6.28	76	0.59	55	170	95	21	10
LCP85-313	LCP85-336	90	6.47	92	9.65	99	0.66	25	189	92	21	5
LCP85-316	CP67-412	91	2.73	21	4.78	17	0.58	45	134	28	23	66
LCP85-336	CP72-370	91	1.76	2	4.50	11	0.39	0	118	5	20	4
LCP85-336	CP76-331	90	4.73	39	6.58	42	0.71	43	154	15	24	71
LCP85-336	CP77-407	90	3.37	3	6.65	46	0.50	2	149	10	20	1
LCP85-336	LCP81-030	90	4.77	40	7.83	88	0.60	11	149	10	23	28
LCP85-336	LCP85-336	90	3.68	9	7.18	69	0.52	3	150	11	21	4
LCP85-336	90P3	90	4.80	42	7.17	68	0.69	34	169	48	23	32
LCP85-336	90P4	90	5.33	66	8.98	98	0.58	8	169	45	21	4
LCP85-336	91P5	91	2.46	12	4.93	22	0.50	13	121	9	23	48
LCP85-376	CP78-317	90	3.29	3	5.85	12	0.56	5	167	42	21	3
LCP85-384	CP70-1082	91	2.60	17	5.10	29	0.51	18	136	33	22	29
LCP85-384	CP74-383	91	2.96	33	6.08	71	0.48	9	131	24	21	13
LCP85-384	CP75-1082	90	5.30	65	5.70	10	0.93	97	158	18	27	99
LCP85-384	CP75-1082	91	4.03	81	6.40	81	0.63	71	166	91	22	26
LCP85-384	CP76-331	91	3.29	48	5.30	37	0.62	66	167	92	21	17
LCP85-384	CP78-317	91	3.00	34	5.38	41	0.55	32	135	32	22	43
LCP85-384	CP80-313	90	2.89	2	5.75	10	0.50	3	140	3	21	7
LCP85-384	CP80-329	90	6.90	96	9.05	98	0.76	61	174	62	23	52

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
LCP85-384	HoCP85-845	91	3.88	76	6.75	91	0.58	45	151	71	22	21
LCP85-384	CP88-2032	91	3.48	60	5.10	28	0.68	84	169	94	22	40
LCP85-384	LCP81-010	90	4.42	26	5.70	10	0.78	68	170	50	24	70
LCP85-384	LCP81-010	91	3.28	47	5.20	33	0.65	77	137	35	25	90
LCP85-384	LCP81-030	91	3.42	56	7.23	96	0.46	6	119	6	22	33
LCP85-384	LCP82-089	91	3.10	39	5.80	58	0.55	30	180	97	20	1
LCP85-384	LCP85-336	90	4.96	47	7.60	82	0.65	20	185	85	21	6
LCP85-384	LCP85-336	91	2.48	13	4.65	13	0.51	15	127	16	22	38
LCP85-384	LCP85-341	91	3.09	39	6.28	77	0.52	22	130	23	22	37
LCP85-384	LCP86-454	91	3.34	50	5.63	48	0.60	56	146	59	23	47
LCP85-384	LCP87-496	91	3.23	45	6.45	82	0.50	14	143	52	21	11
LCP85-384	L88-046	91	3.56	62	6.38	79	0.56	38	144	53	22	22
LCP85-384	L89-120	91	1.54	1	3.73	3	0.38	0	106	1	20	5
LCP85-384	91P5	91	4.18	86	6.45	82	0.64	75	151	69	23	60
LCP85-384	92P4	92	8.08	96	11.28	97	0.74	39	179	42	23	46
LCP85-384	92P9	92	5.66	36	8.20	53	0.69	22	172	28	22	37
LCP86-393	CP77-310	90	4.04	16	6.08	18	0.68	29	182	79	22	13
LCP86-395	L78-063	90	4.59	33	5.85	12	0.77	67	160	23	25	84
LCP86-408	CP70-321	90	4.55	30	6.50	39	0.70	40	161	28	23	52
LCP86-408	CP77-310	90	4.79	41	7.08	64	0.66	23	165	36	23	27
LCP86-408	CP77-310	91	4.45	90	7.80	98	0.57	41	155	77	21	15
LCP86-408	CP80-323	90	6.11	86	7.90	90	0.79	71	177	69	24	65
LCP86-408	LCP82-089	91	3.47	60	6.05	69	0.58	47	144	53	22	39
LCP86-408	LCP85-384	90	3.66	8	6.18	21	0.60	10	165	36	21	9
LCP86-408	LCP85-384	91	3.70	69	6.45	81	0.57	42	147	60	22	27
LCP86-420	LCP81-030	90	5.00	49	6.73	50	0.74	54	209	98	21	8
LCP86-420	L78-063	90	5.96	83	7.38	77	0.81	75	185	86	24	57
LCP86-422	CP77-407	91	4.15	85	6.78	92	0.61	59	155	77	22	31
LCP86-422	CP80-313	91	4.57	92	7.35	97	0.64	72	150	67	23	58
LCP86-429	CP70-321	91	3.92	77	6.58	87	0.60	57	143	51	23	57
LCP86-429	CP72-370	90	5.49	71	6.25	22	0.88	91	158	19	27	98
LCP86-429	CP75-1082	90	5.17	57	5.75	10	0.90	95	179	72	25	92
LCP86-429	CP75-361	91	3.37	52	5.90	62	0.57	40	128	19	23	68
LCP86-429	CP76-331	90	5.34	67	6.73	50	0.81	76	147	7	26	97
LCP86-429	CP77-310	90	5.44	70	7.25	73	0.74	54	174	59	23	48
LCP86-429	CP77-310	91	3.73	71	5.85	61	0.62	66	149	66	23	47
LCP86-429	CP77-405	90	7.14	97	7.70	86	0.91	96	170	50	26	96
LCP86-429	CP77-405	92	4.98	14	6.23	7	0.78	55	170	25	24	80
LCP86-429	CP77-407	91	3.65	66	6.10	72	0.61	58	140	43	23	64

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
LCP86-429	CP78-317	90	6.30	90	6.95	58	0.91	96	189	90	25	85
LCP86-429	CP80-323	91	3.73	71	5.65	50	0.66	79	151	71	23	73
LCP86-429	CP85-830	90	4.92	46	6.47	36	0.76	62	179	75	23	47
LCP86-429	HoCP85-845	91	1.99	4	4.60	13	0.42	2	107	1	22	27
LCP86-429	CP88-718	91	3.04	37	5.25	35	0.59	50	122	10	24	86
LCP86-429	LCP81-010	90	5.87	82	7.58	81	0.78	68	182	79	23	49
LCP86-429	LCP81-030	90	6.45	92	7.35	76	0.88	90	185	85	25	81
LCP86-429	LCP81-030	92	6.04	53	7.90	45	0.77	49	183	52	23	48
LCP86-429	LCP85-336	90	5.30	64	7.08	65	0.75	56	167	40	24	66
LCP86-429	LCP85-384	90	5.05	52	6.60	44	0.77	64	175	65	24	56
LCP86-429	LCP86-395	90	5.11	55	6.08	18	0.81	77	162	30	25	91
LCP86-429	LCP86-402	90	5.19	58	6.15	20	0.84	84	162	29	26	94
LCP86-429	LCP86-454	91	3.81	73	6.45	82	0.58	47	143	52	22	45
LCP86-429	LCP87-496	90	4.64	35	7.35	76	0.62	13	147	7	23	36
LCP86-429	L78-063	90	3.88	13	6.33	27	0.61	13	173	55	22	10
LCP86-429	L88-063	90	5.19	58	6.88	54	0.76	61	169	45	24	66
LCP86-429	L89-120	91	3.01	35	5.60	46	0.54	25	140	44	22	31
LCP86-429	L90-190	92	6.70	73	9.35	84	0.70	28	173	30	22	34
LCP86-429	91P3	91	3.37	52	5.75	55	0.59	51	139	41	23	61
LCP86-450	LCP82-089	91	4.31	88	6.78	92	0.64	74	140	43	24	77
LCP86-454	CP87-626	91	2.89	29	5.35	39	0.52	23	135	31	22	35
LCP86-454	92P4	92	6.03	51	7.70	38	0.80	63	175	33	24	77
LCP86-496	CP77-407	90	4.93	47	7.93	91	0.60	11	168	44	21	5
LCP87-017	CP70-321	91	3.82	73	6.00	67	0.65	76	146	59	24	75
LCP87-017	CP76-331	90	3.79	10	5.65	8	0.67	27	156	17	23	45
LCP87-017	CP76-331	91	1.93	3	3.75	3	0.49	11	114	3	23	60
LCP87-017	CP87-667	90	4.50	29	6.63	45	0.67	29	161	26	23	42
LCP87-017	CP87-667	92	7.15	84	8.95	80	0.78	53	178	40	23	65
LCP87-017	LCP85-384	91	3.76	72	6.25	75	0.60	56	153	74	22	31
LCP87-017	LCP87-017	92	5.94	47	8.90	79	0.66	15	176	35	22	20
LCP87-017	LCP87-472	90	5.16	56	6.93	56	0.74	55	169	46	24	55
LCP87-017	L89-097	91	2.51	14	5.00	24	0.47	8	111	3	23	58
LCP87-017	US78-026	90	6.33	90	7.50	79	0.85	87	215	99	22	23
LCP87-017	91P1	91	2.90	30	5.55	44	0.52	20	130	22	22	36
LCP87-017	92P1	92	5.21	19	7.04	25	0.79	57	205	83	22	28
LCP87-023	LCP81-010	91	4.15	85	6.40	80	0.65	76	142	50	24	78
LCP87-023	LCP81-030	90	4.39	23	6.30	25	0.70	37	166	37	23	44
LCP87-023	90P2	90	4.89	45	4.98	3	0.99	99	181	78	26	97
LCP87-020	CP88-702	91	3.76	72	6.33	78	0.60	56	163	89	21	20

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pcnt'l	mean	pcnt'l	mean	pcnt'l	mean	pcnt'l	mean	pcnt'l
			kg		no.		kg		cm		mm	
LCP87-020	LCP82-089	91	3.17	42	4.85	20	0.66	81	162	88	23	49
LCP87-023	CP76-331	91	3.03	36	5.90	62	0.52	21	163	89	20	2
LCP87-472	CP78-317	91	2.81	24	5.65	50	0.52	22	140	44	21	13
LCP87-492	CP76-331	90	4.95	47	7.05	63	0.70	37	149	10	24	71
LCP87-492	CP77-405	90	5.69	79	7.03	62	0.80	74	179	74	24	59
LCP87-492	LCP85-384	90	4.65	36	8.38	94	0.55	4	161	27	21	3
LCP87-492	LCP85-384	91	2.58	17	5.78	56	0.44	4	145	54	19	1
LCP87-494	90P4	90	5.22	60	7.15	67	0.72	46	184	83	23	28
LCP87-496	CP76-331	90	5.06	53	6.95	58	0.73	47	151	12	25	85
LCP87-496	L89-136	91	3.39	55	5.85	60	0.58	45	153	75	22	21
LCP87-496	91P4	91	3.22	45	6.15	73	0.51	16	129	20	22	35
LCP88-091	CP89-819	92	6.53	68	8.40	64	0.76	47	181	48	23	57
LCP88-091	LCP88-091	90	1.47	0	4.60	1	0.32	0	103	0	20	1
LHo83-153	92P9	92	5.39	23	7.75	40	0.68	17	165	17	22	43
LHO83-153	LCP82-089	92	5.47	27	7.94	46	0.69	19	193	68	21	14
L75-002	LCP87-017	92	6.86	79	8.03	48	0.92	91	215	92	23	53
L78-063	90P1	90	8.37	99	8.55	96	0.96	98	197	96	25	80
L78-063	92P3	92	8.80	98	11.00	96	0.82	69	184	54	23	69
L78-063	92P4	92	6.09	53	8.35	61	0.74	38	173	30	23	61
L78-063	92P5	92	6.30	61	8.18	53	0.78	52	162	12	24	88
L82-107	CP69-373	90	4.06	16	6.20	21	0.64	16	159	22	22	24
L84-290	LCP82-089	91	2.63	18	5.05	25	0.52	23	153	74	21	7
L88-028	LCP81-030	91	2.46	12	4.68	14	0.51	17	124	12	23	46
L88-028	91P4	91	2.44	11	4.80	18	0.47	7	140	47	20	4
L88-030	CP75-1082	91	3.49	60	5.00	25	0.71	89	135	31	25	96
L88-030	CP77-310	91	3.00	34	6.00	67	0.49	11	130	22	22	29
L88-030	LCP81-030	90	4.46	27	6.60	43	0.67	28	169	46	22	24
L88-047	90P2	90	4.40	25	6.65	46	0.67	27	166	39	23	31
L88-059	CP75-1082	90	5.96	84	7.90	89	0.75	57	174	62	24	54
L88-059	LCP81-010	90	3.49	5	6.28	24	0.57	6	163	32	21	6
L88-060	LCP87-472	90	6.52	94	8.58	96	0.76	62	172	54	24	57
L88-063	L88-063	90	1.95	0	4.35	0	0.45	0	124	1	21	4
L88-069	CP87-662	90	5.50	72	7.28	74	0.77	65	191	93	23	30
L88-072	90P1	90	4.39	23	6.60	44	0.69	35	156	16	24	62
L88-073	CP75-1082	91	3.38	53	4.75	16	0.71	88	134	30	26	98
L88-073	LCP87-472	91	6.35	99	8.75	99	0.72	91	147	60	24	89
L88-075	91P4	91	3.39	54	6.63	89	0.51	16	173	95	19	0
L89-095	91P3	91	3.50	61	5.18	31	0.68	84	156	80	23	62
L89-101	CP77-310	91	2.33	9	4.90	22	0.48	8	133	27	21	17

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l	mean	pct'l
			kg		no.		kg		cm		mm	
L89-110	CP76-331	91	2.37	10	4.50	11	0.53	24	118	5	24	83
L89-110	LCP85-336	91	2.84	26	5.20	32	0.55	32	129	21	23	58
L89-113	LCP85-384	91	3.71	70	6.73	90	0.56	35	156	81	21	8
L89-113	LCP86-454	92	8.11	96	8.40	64	0.96	92	189	61	25	92
L89-113	92P5	92	6.25	61	6.85	21	0.91	88	192	63	24	85
L89-115	CP77-310	91	2.85	26	6.08	71	0.48	9	128	18	21	14
L89-115	LCP85-384	91	2.71	21	5.30	37	0.52	20	148	64	21	9
L89-116	CP76-331	91	2.10	7	4.78	17	0.45	5	111	2	22	42
L89-118	CP78-317	91	3.13	40	5.93	64	0.53	25	132	26	22	42
L89-118	LCP86-454	91	3.42	57	5.23	33	0.66	79	148	63	24	79
L89-121	CP77-407	91	3.39	55	5.30	37	0.64	74	155	78	23	48
L89-121	CP78-317	91	3.63	64	5.70	52	0.63	69	150	67	23	53
L89-134	CP76-331	91	2.86	27	5.30	36	0.54	27	126	15	23	62
L89-134	LCP85-384	91	3.43	58	5.80	58	0.59	54	149	65	22	38
L89-140	91P4	91	3.35	51	6.08	71	0.56	37	148	64	21	19
L89-143	91P1	91	2.72	21	5.13	29	0.52	23	145	56	21	7
L89-152	CP76-331	91	3.21	44	6.45	82	0.48	9	116	4	23	52
L89-152	LCP85-384	91	2.18	8	4.85	20	0.41	2	120	8	20	3
L89-163	CP76-331	91	3.27	47	5.73	54	0.56	38	126	13	23	74
L89-163	LCP85-384	91	3.63	65	6.63	89	0.55	28	161	86	21	7
L90-170	CP77-310	92	5.34	21	7.08	26	0.75	40	180	44	23	49
L90-178	CP79-318	92	3.68	3	7.45	32	0.49	1	162	13	19	2
L90-178	LCP85-384	92	5.10	16	9.15	84	0.57	5	168	21	20	4
L90-181	92P3	92	6.52	67	8.06	49	0.86	77	206	86	23	46
L90-190	92P1	92	4.69	8	9.00	83	0.53	2	152	3	21	7
L90-191	CP76-331	92	4.90	11	7.48	34	0.66	14	150	1	23	68
L90-191	CP87-626	92	5.11	17	6.40	12	0.80	65	198	73	23	50
L90-200	CP87-626	92	5.47	26	6.23	7	0.90	85	213	92	23	50
L90-200	LCP81-010	92	6.79	76	6.84	20	1.02	96	220	96	24	80
L90-200	92P5	92	6.41	65	6.36	11	1.05	97	222	96	24	82
L90-216	CP76-331	92	4.80	9	6.90	23	0.73	36	183	53	22	27
L90-216	US80-004	92	6.79	75	8.55	69	0.80	61	177	37	23	71
US77-010	CP78-317	90	5.70	79	7.25	72	0.79	70	192	94	23	34
US77-010	92P6	92	8.67	97	10.75	95	0.79	59	192	64	23	45
US77-017	CP72-356	90	8.31	99	11.65	99	0.71	43	147	7	25	89
US77-017	CP72-356	91	4.72	94	6.58	87	0.73	93	174	96	23	49
US77-017	CP80-329	90	5.23	61	6.90	55	0.75	57	161	28	24	76
US78-026	LCP87-017	91	3.62	64	6.53	85	0.54	27	161	88	20	3
US78-026	90P1	90	4.39	24	6.68	48	0.65	18	175	63	22	9

Table 9. Continue

Female	Male	Series	Plant wt.		Stalks per plant		Stalk wt.		Stalk length		Stalk diam.	
			mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l	mean	pc nt'l
			kg		no.		kg		cm		mm	
US78-026	90P1	92	4.84	10	7.45	34	0.64	11	169	24	22	17
US78-026	90P3	90	6.00	84	7.00	60	0.85	86	183	81	24	69
US78-026	91P4	91	2.82	25	5.63	48	0.50	14	153	75	20	1
US78-026	92P1	92	6.34	63	8.98	82	0.70	29	206	84	21	6
US78-026	92P3	92	6.60	70	8.70	72	0.76	45	199	74	21	16
US78-026	92P6	92	6.71	74	8.98	82	0.76	44	196	69	22	25
US78-026	92P7	92	5.98	48	10.50	93	0.57	5	193	67	19	1
US80-004	LCP85-384	91	4.10	83	7.08	96	0.58	46	147	62	22	37
US86-002	LCP85-384	90	4.60	34	6.55	41	0.70	41	160	23	24	61

1994 LOUISIANA "L" NURSERY VARIETY TRIALS

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Five years after the initial hybridization of parents, clones that have met or exceeded criteria for important characteristics at previous selection stages are assigned permanent numbers by the Louisiana (L) Sugarcane Variety Development Program. These varieties are planted in replicated single row "nursery" tests.

One of the objectives of the nursery stage of the selection program is to identify and select varieties that will perform well across the range of environments a commercial variety will probably encounter in Louisiana. Three tests are normally planted during the year of assignment and three additional tests are planted the year after assignment (Table 1).

Nursery trials were planted in single row (six-foot centers), 16-foot long plots using two replications per location in a randomized complete block design. Three commercial check varieties (CP70-321, CP72-370, and LCP82-089) were included in all tests for comparison basis.

Stalk counts were made in August. During the normal harvest season, 10-stalk samples were harvested and hand stripped of leaves. At the St. Gabriel Sucrose laboratory, the samples were weighed and milled to obtain juice for analyses of Brix by refractometer and sucrose by polarization. Cane yield was estimated as the product of stalk weight and stalk number. Sucrose yield was calculated as the product of sucrose content and cane yield.

Analyses of variance was performed for each assigned series, crop, and location-soil texture combination. A combined analysis was performed over locations-soil texture for each assignment series. Minimum significant differences (MSD) were calculated by the Waller-Duncan multiple range tests (SAS, 1985) at the P=0.05 level of significance. Results from Nursery variety trials harvested in 1994 are presented in Tables 2 through 21.

References:

SAS Institute Inc. SAS User's Guide: Statistics, Ver. 5 ed. Cary, NC: SAS Institute Inc., 1985 956pp.

This project was partially funded by the American Sugar Cane League.

Table 1. Planting and harvest dates of nursery tests planted or harvested in 1994.

Series	Location[1]	Soil Texture[2]	Planting Date	Harvest Dates			Varieties[3]	
				1992	1993	1994	No. Planted	No. Harvest
1991	Iberia	B.s.c.	10/11/91	12/10	11/19	10/20	65	6
1991	St. G.	S.c.	11/15/91	12/01	11/08	10/14	65	10
1991	St. G.	C.s.l.	11/16/91	12/01	11/08	10/14	65	10
1991	Peebles	J.s.l.	9/11/92		ns	10/20	39	10
1991	Stoute	B.s.c.	08/20/92		ns	10/16	39	10
1991	Westfield	S.s.c.	10/05/92		11/17	11/01	39	10
1992	Iberia	B.s.c.	10/26/92		12/01	11/04	67	9
1992	St. G.	S.c.	10/26/92		11/11	11/14	70	9
1992	Ardoyne	C.s.l.	09/23/93			11/21	41	9
1992	Lev.-St.J.	D.s.l.	09/23/93			11/17	37	9
1992	Glenwood	C.s.l.	10/04/93			11/10	41	9
1993[4]	St. G	S.c.	10/07/92		11/6	11/8	190	30
1993[4]	St. G	C.s.l.	10/09/92		10/6	11/12	190	30
1993	Iberia	B.s.c.	10/23/93			12/07	42	31
1993	St. G.	C.s.l.	10/20/93			12/05	42	31
1993	Ardoyne	C.s.l.	10/19/93			11/21	42	31
1993	Lev.-St.J.	D.s.l.	08/31/94				28	
1993	Stoute	B.s.c.	08/31/94				28	
1993	Westfield	S.s.c.	10/06/94				28	
1994	Iberia	B.s.c.	10/20/94				45	
1994	St. G.	S.c.	10/17/94				45	
1994	Ardoyne	C.s.l.	10/21/94				45	

[1] Iberia- Iberia Research Station, St. G.- St. Gabriel Research Station, Peebles- Peebles Plantation, Westfield- Westfield Plantation, Stoute- D. Stoute Farm, Ardoyne- U.S.D.A. Ardoyne Farm, Lev.- St. J.- Levert- St. John, Glenwood- Glenwood Plantation.

[2] B.s.c.- Baldwin silty clay, C.s.l.- Commerce silt loam, Galvez- Galvez silt loam, J.s.l.- Jeanerette silt loam, S.c.- Sharkey clay, D.s.l.- Dundee silt loam.

[3] Number of varieties per replication including three commercial checks. All tests contained two replications. ns-not sampled.

[4] Increase tests.

Table 2. 1994 second ratoon means of the 1991 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk weight	Stalk number
	lbs/A	lbs/ton	tons/A	lbs	no/A
CP65-357	9324	261	35.9	36527	1.96
L91-250	9033	242	37.3	36981	2.04
L91-281	11841	270	43.9	47644	1.86
$MSD_{.05}$	NS	NS	NS	3691	NS

Table 3. 1994 second ratoon means of the 1991 "L" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	7110	242	32.1	34939	1.64
CP70-321	6482	267	24.4	24276	2.00
CP74-383	7945	234	33.7	33351	2.00
L91-250	5986	239	24.7	35393	1.37
L91-281	12469	235	52.8	53996	2.03
$MSD_{.05}$	8189	NS	28.7	33145	NS

Table 4. 1994 second ratoon means of the 1991 "L" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	7344	276	26.6	25411	2.09
CP70-321	4543	256	17.3	17091	1.98
CP74-383	10568	242	43.7	39704	2.21
L91-250	15524	265	58.8	55812	2.11
L91-281	15245	231	65.9	62164	2.12
$MSD_{.05}$	6531	23	25.7	17475	NS

Table 5. 1994 second ratoon means of the 1991 "L" series across location[1].

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	8089	260	31.4	31763	1.89
CP70-321	5319	260	20.1	19965	1.99
CP74-383	9256	238	38.7	36527	2.11
L91-250	10181	248	40.2	42728	1.84
L91-281	13185	245	54.2	54601	2.00
$MSD_{.05}$	6506	NS	26.6	18831	NS

[1]Iberia, St. Gabriel Sharkey clay and Commerce silt loam.

Table 6. 1994 first ratoon means of the 1991 "L" series at Peebles Plantation.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP70-321	6707	215	30.8	34258	1.79
CP74-383	6044	206	29.1	29948	1.94
LCP82-089	6084	220	27.7	34939	1.60
L91-250	5738	219	26.2	25183	2.07
L91-281	7756	233	33.4	34258	1.95
$MSD_{.05}$	NS	NS	NS	11173	0.20

Table 7. 1994 first ratoon means of the 1991 "L" series at Stoute Farm.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP70-321	8481	307	27.7	33805	1.64
CP74-383	8328	260	32.2	30628	2.09
LCP82-089	9039	294	30.8	32897	1.88
L91-250	10900	315	34.7	47417	1.46
L91-281	12905	298	43.5	45375	1.91
$MSD_{.05}$	4850	18	17.8	13011	0.40

Table 8. 1994 first ratoon means of the 1991 "L" series at Westfield Plantation.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP70-321	10269	317	32.5	30175	2.13
CP74-383	9310	289	32.2	30175	2.14
LCP82-089	10051	315	32.2	34939	1.82
L91-250	9855	328	30.1	39704	1.51
L91-281	12966	304	42.7	47644	1.79
$MSD_{.05}$	NS	27	NS	9931	0.50

Table 9. 1994 first ratoon means of the 1991 "L" series across locations[1].

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/a	lbs/ton	tons/A	no/A	lbs
CP70-321	8485	280	30.3	32746	1.85
CP74-383	7894	252	31.2	30250	2.05
LCP82-089	8391	277	30.2	34258	1.77
L91-250	8831	287	30.3	37435	1.68
L91-281	11209	278	39.8	42426	1.88
$MSD_{.05}$	1737	20	5.9	12498	NS

[1]Iberia, Peebles, Stoute, Westfield Plantation and St. Gabriel Sharkey clay and Commerce silt loam.

Table 10. 1994 first ratoon means of the 1992 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight	Fiber
	lbs/A	lbs/ton	tons/A	no/A	lbs	%
CP70-321	12145	283	42.9	35393	2.43	12.2
CP74-383	9399	239	38.9	37208	2.08	12.7
LCP82-089	11994	287	41.8	36527	2.28	12.5
L92-307	11310	272	41.6	36300	2.30	12.1
L92-310	13030	276	47.0	34258	2.76	12.4
L92-312	13319	289	46.1	47191	1.95	13.3
L92-313	12541	254	49.5	50594	1.96	12.5
L92-314	14916	267	55.7	43787	2.59	14.4
L92-315	9553	251	38.1	39477	1.93	13.0
L92-319	11243	274	40.9	33805	2.43	11.9
L92-321	9496	277	34.2	27225	2.50	13.7
L92-355	13988	292	47.9	45148	2.12	15.4
$MSD_{.05}$	4318	22	13.8	9233	0.70	1.1

Table 11. 1994 first ratoon means of the 1992 "L" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight	Fiber
	lbs/A	lbs/ton	tons/A	no/A	lbs	%
CP70-321	9907	286	34.3	35620	1.93	13.2
CP74-383	9680	273	35.6	40611	1.75	12.5
LCP82-089	11261	286	39.1	41519	1.86	12.8
L92-307	11873	282	42.5	34485	2.46	12.3
L92-310	11137	279	39.9	33124	2.41	12.6
L92-312	10801	299	36.2	44695	1.62	13.4
L92-313	13537	288	46.7	48779	1.92	12.9
L92-314	10375	254	40.3	38569	2.07	15.1
L92-315	9916	271	36.7	39250	1.87	13.3
L92-319	12372	292	42.4	34939	2.45	12.5
L92-321	10104	278	36.3	31990	2.27	14.2
L92-355	11810	307	38.4	43787	1.76	14.0
$MSD_{.05}$	NS	51	NS	11738	0.60	1.1

Table 12. 1994 first ratoon means of the 1992 "L" series across locations[1].

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight	Fiber
	lbs/A	lbs/ton	tons/A	no/A	lbs	%
CP70-321	11026	285	38.6	35506	2.18	12.7
CP74-383	9540	256	37.2	38909	1.91	12.6
LCP82-089	11627	287	40.4	39023	2.07	12.7
L92-307	11592	277	42.0	35393	2.38	12.2
L92-310	12083	278	43.4	33691	2.58	12.5
L92-312	12060	294	41.1	45943	1.79	13.3
L92-313	13039	271	48.1	49686	1.94	12.7
L92-314	12645	260	48.0	41178	2.33	14.8
L92-315	9734	261	37.4	39363	1.90	13.1
L92-319	11807	283	41.7	34372	2.44	12.2
L92-321	9800	277	35.2	29607	2.38	13.9
L92-355	12899	300	43.2	44468	1.94	14.7
$MSD_{.05}$	3587	25	10.5	4675	0.40	0.9

[1]Iberia and St. Gabriel Research Station on a Sharkey clay.

Table 13. 1994 plant cane means of the 1992 "L" series acros locations[1].

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight	Fiber
	lbs/A	lbs/ton	tons/A	no/A	lbs	%
CP65-357	9496	275	34.5	28511	2.44	14.8
CP70-321	9233	273	33.6	27679	2.41	12.4
LCP82-089	11550	282	40.6	34788	2.37	13.3
L92-307	13893	261	52.6	34863	3.03	11.5
L92-310	9672	251	38.3	24351	3.16	12.8
L92-312	10513	292	36.0	33880	2.13	13.5
L92-313	9915	257	38.6	32973	2.36	12.9
L92-314	10197	259	39.3	32897	2.44	14.7
L92-315	11438	258	43.8	38796	2.26	12.9
L92-319	12563	277	45.3	30099	3.04	11.6
L92-321	14120	281	50.3	32821	3.05	14.9
L92-355	11084	298	37.3	29570	2.52	15.1
$MSD_{.05}$	1868	20	5.6	4573	0.30	

[1]Ardoyne Farm, Glenwood and Levert-St. John Plantations.

Table 14. 1994 plant cane means of the 1992 "L" series at Ardoyne Farm.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight	Fiber
	lbs/A	lbs/ton	tons/A	no/A	lbs	%
CP65-357	11132	295	37.8	30855	2.45	14.8
CP70-321	11639	290	40.1	31082	2.58	12.4
LCP82-089	13142	299	44.1	39930	2.20	13.3
L92-307	18820	298	63.3	41519	3.07	11.5
L92-310	11533	282	41.0	25864	3.18	12.8
L92-312	11479	310	37.1	36754	2.01	13.5
L92-313	10698	275	38.9	32897	2.37	12.9
L92-314	12003	270	44.5	40838	2.19	14.7
L92-315	14440	292	49.4	42199	2.34	12.9
L92-319	14140	288	48.9	34259	2.84	11.6
L92-321	16956	290	58.6	36981	3.17	14.9
L92-355	12081	302	40.5	33805	2.34	15.1
$MSD_{.05}$	5737	23	19.7	14055	0.50	1.6

Table 15. 1994 plant cane means of the 1992 "L" series at Glenwood Plantation.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	9259	258	35.9	31309	2.31
CP70-321	9267	269	34.8	29494	2.35
LCP82-089	12066	290	41.6	38796	2.15
L92-307	11057	251	44.0	31990	2.78
L92-310	9618	241	39.9	25864	3.11
L92-312	10905	295	36.9	34939	2.12
L92-313	9992	255	39.2	34939	2.25
L92-314	9181	253	36.2	31536	2.30
L92-315	10453	256	40.5	39704	2.04
L92-319	12562	273	46.1	32216	2.86
L92-321	12798	292	43.6	29494	2.95
L92-355	11171	309	36.2	28814	2.52
$MSD_{.05}$	4850	39	15.8	10822	0.50

Table 16. 1994 plant cane means of the 1992 "L" series at Levert-St. John Plantation.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	8098	271	29.9	23369	2.56
CP70-321	6793	261	26.0	22461	2.30
LCP82-089	9441	259	36.1	25637	2.77
L92-307	11803	235	50.6	31082	3.25
L92-310	7865	231	34.2	21327	3.21
L92-312	9157	271	33.9	29948	2.27
L92-313	9054	242	37.8	31082	2.47
L92-314	9406	253	37.2	26318	2.83
L92-315	9420	227	41.7	34485	2.41
L92-319	10989	271	40.9	23822	3.42
L92-321	12607	260	48.7	31990	3.03
L92-355	10002	284	35.2	26091	2.70
$MSD_{.05}$	5337	31	22.4	14131	0.40

Table 17. 1994 first ratoon means of 1993 "L" series increase tests at St. Gabriel[1].

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP70-321	10016	284	35.2	30174	2.33
LCP82-089	10376	284	36.6	32954	2.24
L93-358	8717	259	33.6	30628	2.20
L93-363	11067	264	42.0	41745	2.01
L93-364	10499	294	35.7	47644	1.51
L93-365	17972	295	61.2	41745	3.03
L93-366	11957	290	41.0	52636	1.56
L93-371	10581	267	39.7	34032	2.34
L93-372	9773	269	36.4	39250	1.85
L93-374	8223	287	28.7	34485	1.67
L93-376	12330	293	42.1	43106	1.96
L93-378	12245	288	42.6	52182	1.64
L93-380	8165	286	28.3	32670	1.73
L93-382	10454	309	33.9	34259	2.01
L93-385	14061	269	52.3	39023	2.67
L93-386	9378	261	36.0	37435	1.93
L93-387	6550	248	25.9	30855	1.66
L93-388	12417	286	43.5	41065	2.14
L93-390	9960	257	38.9	36981	2.14
L93-391	10388	275	37.8	31309	2.43
L93-393	4027	270	14.8	24956	1.14
L93-394	10033	298	33.7	35166	1.93
L93-395	7845	269	29.1	33351	1.75
L93-396	7813	254	30.8	32217	1.82
L93-397	7507	295	25.4	28814	1.69
L93-398	7195	267	26.9	30855	1.73
L93-399	10430	289	36.1	34485	2.08
L93-400	11383	244	46.0	46737	1.98
L93-401	12742	293	43.7	43560	2.01
L93-402	8729	267	32.7	43787	1.50
$MSD_{0.05}$	4569	30	15.2	9863	0.55

[1]Combined St. Gabriel Commerce silt loam and Sharkey clay soil tests (one rep each).

Table 18. 1994 plant cane means of the 1993 "L" series at Ardoyne Farm.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	9983	280	36.2	26998	2.69
CP70-321	13525	273	49.7	37435	2.65
LCP82-089	12586	287	43.7	32897	2.67
L93-358	15026	273	55.2	42426	2.60
L93-363	10898	271	40.3	35847	2.25
L93-364	10896	298	36.6	36300	2.03
L93-365	15986	292	54.8	34032	3.22
L93-366	11271	303	37.3	39477	1.88
L93-371	14034	260	54.1	33124	3.27
L93-372	12089	258	46.8	38569	2.43
L93-373	10737	270	39.9	28133	2.84
L93-374	10722	283	37.9	36981	2.07
L93-376	10613	288	37.0	32217	2.29
L93-378	13939	290	48.1	40611	2.36
L93-380	12384	290	42.8	39250	2.19
L93-382	13379	309	43.4	32897	2.64
L93-385	14114	282	50.1	36073	2.79
L93-386	14038	277	50.7	41972	2.42
L93-387	13112	278	47.6	40157	2.38
L93-388	11227	282	40.0	35393	2.26
L93-389	14164	278	51.0	36981	2.75
L93-390	14931	271	55.2	41519	2.66
L93-391	12995	291	44.8	30629	2.92
L93-392	12955	295	44.1	27452	3.23
L93-393	11733	279	42.0	40838	2.08
L93-394	12821	299	43.0	34258	2.52
L93-395	15447	293	52.7	40157	2.62
L93-396	14058	262	53.8	38796	2.77
L93-397	11767	298	39.4	28133	2.81
L93-398	9598	268	35.8	36754	1.95
L93-399	13903	281	49.5	38342	2.60
L93-400	12875	259	49.7	49232	2.02
L93-401	10271	272	38.2	33805	2.25
L93-402	9535	264	35.9	40838	1.75
$MSD_{.05}$	4148	21	14.1	10599	0.40

Table 19. 1994 plant cane means of the 1993 "L" series at the Iberia Research Station.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	7339	271	27.1	20646	2.62
CP70-321	7374	259	28.5	23822	2.40
LCP82-089	10857	270	40.4	32670	2.47
LCP85-384	14756	280	52.7	42199	2.50
L93-358	8364	253	33.1	22007	3.02
L93-363	11292	254	44.5	31990	2.78
L93-364	6919	283	24.5	26318	1.86
L93-365	10838	285	38.2	24049	3.18
L93-366	7690	280	27.4	27226	2.00
L93-371	7099	261	27.2	18604	2.93
L93-372	6447	246	26.3	24730	2.13
L93-373	8213	258	31.9	25184	2.54
L93-374	8813	263	33.5	30401	2.21
L93-376	6456	244	26.2	22461	2.33
L93-378	11408	290	39.3	36981	2.13
L93-380	6160	263	23.6	19965	2.36
L93-382	8233	282	29.3	24049	2.43
L93-385	7985	264	30.5	23369	2.61
L93-386	7938	250	31.8	26998	2.37
L93-387	9054	263	34.7	32216	2.12
L93-388	7600	254	29.9	27679	2.17
L93-389	8397	265	31.7	24503	2.58
L93-390	6934	239	29.1	23595	2.47
L93-391	9342	274	34.1	23142	2.95
L93-392	6415	256	25.1	17243	3.00
L93-393	7711	259	29.8	26318	2.23
L93-394	7082	280	25.3	22915	2.21
L93-395	7906	283	27.9	25183	2.22
L93-396	8656	234	37.1	24730	3.03
L93-397	10573	272	38.9	26772	2.93
L93-398	6763	250	27.0	22915	2.37
L93-399	12829	281	45.5	35847	2.54
L93-400	7566	224	33.8	33578	2.01
L93-401	8355	263	31.8	24503	2.60
L93-402	9871	270	36.6	39023	1.88
$MSD_{.05}$	2706	26	10.9	6672	0.39

Table 20. 1994 plant cane means of the 1993 "L" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/ton	lbs/ton	tons/A	no/A	lbs
CP65-357	11035	283	38.8	28360	2.74
CP70-321	13006	265	49.1	29494	3.33
LCP82-089	11462	266	43.2	31309	2.78
L93-358	11101	271	41.0	29267	2.81
L93-363	12711	267	47.7	34032	2.80
L93-364	9750	293	33.3	33578	1.99
L93-365	12301	270	45.5	31309	2.91
L93-366	12969	270	48.0	37510	2.56
L93-371	8664	259	33.4	22234	3.00
L93-372	9256	242	38.2	34258	2.23
L93-373	11737	275	42.7	25637	3.33
L93-374	10169	261	39.0	36754	2.12
L93-376	10991	264	41.2	32897	2.49
L93-378	13717	274	50.2	39930	2.52
L93-380	12980	274	47.4	37208	2.55
L93-382	10480	295	35.7	27225	2.62
L93-385	13445	277	48.5	31309	3.12
L93-386	11911	265	45.2	33578	2.69
L93-387	11181	263	42.5	34939	2.44
L93-388	11367	267	42.6	34259	2.49
L93-389	14589	255	57.3	32216	3.56
L93-390	11862	239	49.5	33805	2.92
L93-391	12804	269	47.6	29494	3.25
L93-392	13055	258	50.6	27452	3.73
L93-393	9609	268	36.0	31082	2.30
L93-394	12088	291	41.6	25637	3.24
L93-395	10575	265	40.0	32897	2.43
L93-396	8576	240	35.8	28586	2.49
L93-397	11404	275	41.5	31990	2.58
L93-398	11406	265	43.0	33578	2.57
L93-399	10557	267	39.5	26545	2.98
L93-400	13448	247	54.4	44241	2.49
L93-401	9763	265	36.5	28133	2.60
L93-402	9537	264	36.2	34031	2.13
$MSD_{.05}$	6599	32	19.9	10703	0.60

Table 21. 1994 plant cane means of the 1993 "L" series across locations[1].

Variety	Sucrose yield	Sucrose content	Cane yield	Stalk number	Stalk weight
	lbs/A	lbs/ton	tons/A	no/A	lbs
CP65-357	9452	278	34.0	25335	2.68
CP70-321	11302	266	42.4	30250	2.79
LCP82-089	11635	274	42.4	32292	2.64
LCP85-384	14756	280	52.7	42199	2.50
L93-358	11497	266	43.1	31233	2.81
L93-363	11634	264	44.1	33956	2.61
L93-364	9188	291	31.5	32065	1.96
L93-365	13042	282	46.1	29796	3.10
L93-366	10976	282	39.0	35133	2.21
L93-371	9932	260	38.2	24654	3.06
L93-372	9264	249	37.1	32519	2.26
L93-373	10229	267	38.2	26318	2.90
L93-374	9901	269	36.8	34712	2.13
L93-376	9353	265	34.8	29192	2.37
L93-378	13021	285	45.8	39174	2.33
L93-380	10508	275	37.9	32141	2.36
L93-382	10697	295	36.1	28057	2.56
L93-385	11848	274	43.0	30250	2.84
L93-386	11296	264	42.6	34183	2.49
L93-387	10821	267	40.6	35263	2.28
L93-388	10065	268	37.5	32443	2.30
L93-389	11942	268	44.5	31037	2.84
L93-390	11242	250	44.6	32973	2.68
L93-391	11714	278	42.2	27755	3.04
L93-392	10808	270	39.9	24049	3.32
L93-393	9684	269	35.9	32746	2.20
L93-394	10663	290	36.6	27603	2.66
L93-395	11309	280	40.2	32746	2.42
L93-396	10430	245	42.2	30704	2.76
L93-397	11248	282	39.9	28965	2.77
L93-398	9255	261	35.3	31082	2.29
L93-399	12430	276	44.8	33578	2.70
L93-400	11296	244	45.9	42350	2.17
L93-401	9463	266	35.5	28813	2.48
L93-402	9648	266	36.2	37964	1.92
$MSD_{.05}$	3725	13	13.3	5987	0.36

[1]Ardoyne Farm, Iberia, and St. Gabriel on a Commerce silt loam.

1994 LOUISIANA (L) INFIELD VARIETY TRIALS

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The infield variety trials of the Louisiana (L) Sugarcane Variety Development Program have traditionally been planted from the year after number assignment through the year of introduction to outfield test locations for seed increase. These trials are the first machine harvested tests in the program. The purpose of the trials is to estimate yields on a larger plot basis than used by earlier stages in the selection program and to initiate screening of experimental clones for suitability to mechanical harvest.

The Louisiana sugarcane crop of 1994 was outstanding compared with recent years. The St. Gabriel crop looked promising early in the year because of the mild tempertures during the 1993-94 winter and an adequate amount of rainfall during the growing season. Below normal rainfall during the fall months resulted in very good cane quality and exceptional harvest conditions.

Normal recommended cultural practices were used in 1994. Sinbar (1/2 lb./A terbacil) + Atrazine (2 qt./A) was applied to tests on Sharkey clay and Sencor 4L (2 qt./A;41% AI) + Atrazine (2 qt./A) was applied to tests on Commerce silt loam after planting in the fall. In early February, 2-4,D (1 qt./A;46.88% AI) + Atrazine (2 qt./A) was applied to all plant-cane and ratoon trials. During the third week of April, Sencor 4L (2 qt.;41% AI) + 2-4,D (1 qt./A; 46.88% AI) was applied after off-barring. Asulox (4.0 pts./A) was applied once in late April and again, where needed, in May. Fields were fertilized with (120 lbs. N; 32% liquid N) in April. Sugarcane borer (*Diatrea saccharalis F*) populations were monitored on a weekly bases during the months of June, July, and August. Borer infestations in the cane on lighter textured soils reached economic thresholds during July and August and were treated with helicopter applications of Guthion, (0.75 lbs./A) once on July 16 and a second time on August 14.

At Ardoyne Farm, normal cultural practices were used in 1994. In early April, Karmex (1 lb./acre) and Weedmaster (1 qt./acre) were applied. During the last week of April, tests were fertilized at a rate of 100 lbs. N, 34 lbs. P, and 67 lbs. K. Atrazine (1.5 qt./acre plus Prowl 3.3 EC (2 qt./acre) were applied at layby during the first week of June.

The infield variety trials were planted in Sharkey clay (very- fine, montmorillonitic, thermic, Aeric Epiaquert) and Commerce silt loam (fine-silty, mixed, nonacid, thermic, Aeric Fluvaquent) soils on the St. Gabriel Research Station and in a Commerce silt loam at the USDA-

This project was partially funded by the American Sugar Cane League.

ARS Ardoyne Farm near Chacahoula, LA. For each assignment series, infield tests have traditionally been planted for three years. In the past, the LAES and USDA would plant their experimental varieties on their farms in the first year of the test and would also exchange the same varieties to plant seedcane plots at the other agency's farm. Starting in 1993, varieties were planted in only one infield test at St. Gabriel prior to introduction to the outfield tests. In 1992, the last replanting of the infield tests was discontinued and the introductory plots of the outfield tests were planted in a standardized fashion to enable comparative yield estimates to be made in future years.

The 1993 L series was planted in one trial on August 30, 1994 (Table 1). Randomized complete block designs with plots 16 feet long by three rows wide on six foot centers were used in trial. Three commercial check varieties, CP72-370, CP70-321, and LCP82-089 were included in the tests.

From October 18 through November 20, 1994 (Table 1), unburned plots were mechanically cut and weighed with a tractor mounted hydraulic weigh rig. No adjustments were made for trash weight. Ten-stalk samples, stripped of leaves, were brought to the St. Gabriel Sucrose laboratory, weighed, and milled to obtain juice for analysis. Brix was measured by refractometer and sucrose by polarization. Sucrose yield was estimated as the product of cane yield and sucrose content.

Analysis of variance was performed for each crop and assignment series over and by soil type when appropriate. Minimum significant differences (MSD) were calculated by the Waller-Duncan multiple range test (SAS, 1985) at the $P=0.05$ level of significance.

References:

SAS Institute Inc. SAS User's Guide: Statistics, Ver. 5 ed. Cary, NC: SAS Institute Inc., 1985 956pp.

Table 1. Planting and harvest dates of infield tests[1].

Assignment Series	Reps	Soil[2] Texture	Planting Dates	Harvest Dates 1994	1993	1992	Varieties[3] No. Planted	No. Harvest
1988 L & CP	2	S.c.	09/26/90	10/18	10/22	10/23	41	4
1988 CP	2	C.s.l.	08/22/90	10/18	10/22	10/23	41	4
1989 L & CP	2	C.s.l.*	10/01/91	10/18	10/14	10/28	56	7
1989 L	2	S.c.	09/25/90	10/18	10/21	11/20	49	4
1989 L & CP	2	C.s.l.	09/26/91	10/18	11/01	12/04	53	7
1990 CP	2	C.s.l.*	09/15/92	11/07	11/18	11/18	42	8
1990 CP	2	S.c.	09/09/92	10/31	11/16		41	8
1990 CP	2	C.s.l.	09/08/92	10/31	11/22		41	8
1990 CP	2	C.s.l.*	09/02/93	11/23			5	10
1991 L	2	S.c.	09/30/92	10/31	11/16		39	7
1991 CP	2	C.s.l.*	09/03/93	12/01			13	13
1992 CP	2	C.s.l.*	09/06/94				23	
1992 L	2	S.c.	09/07/93	11/16			35	12
1993 L	2	S.c.	08/30/94				31	

[1] Tests conducted at the St. Gabriel Research Station and the U.S.D.A. Ardoyne Farm.
[2] C.s.l.-Commerce silt loam, S.c.-Sharkey clay, C.s.l.*-Ardoyne Farm Commerce silt loam.
[3] Number of varieties per replications including 3 commercial checks.

Table 2. 1994 second ratoon means of the 1988 "CP" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	5859	23.7	247	1.75	27134
CP70-321	7209	26.4	273	2.10	25228
CP74-383	6831	26.8	255	1.95	27492
HoCP88-739	10841	37.9	286	2.00	37707
$MSD_{.05}$	2632	9.4	27	0.30	8237

Table 3. 1994 second ratoon means of the 1988 "CP" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	6191	24.5	253	2.10	23218
CP70-321	7510	28.2	266	2.30	24897
CP74-383	8022	31.4	256	2.20	28592
HoCP88-739	8687	30.3	287	1.90	31895
$MSD_{.05}$	1839	NS	20	NS	6488

Table 4. 1994 second ratoon means of the 1988 "CP" series across locations[1].

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	6025	24.1	250	1.93	25176
CP70-321	7359	27.3	269	2.20	25062
CP74-383	7426	29.1	256	2.08	28042
HoCP88-739	9764	34.1	287	1.95	34801
$MSD_{.05}$	2901	NS	12	NS	2403

[1]St. Gabriel Sharkey clay and Commerce silt loam.

Table 5. 1994 second ratoon means of the 1989 "L" & "CP" series at the Ardoyne Farm.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP65-357	8483	30.5	278	2.04	30085	12.9
CP70-321	7648	33.1	231	2.06	32174	----
CP74-383	6699	30.1	222	2.13	28299	----
L89-113	7786	31.9	244	1.80	35477	14.4
HoCP89-843	8093	35.2	230	1.87	37690	12.1
HoCP89-846	7606	31.4	242	1.69	37980	12.6
Ho89-889	8368	32.3	259	2.08	31062	12.6
$MSD_{.05}$	NS	NS	24	0.20	NS	1.1

Table 6. 1994 second ratoon means of the 1989 "L" series at St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	6052	25.7	236	1.95	26316
CP70-321	4811	18.1	265	1.85	19468
CP74-383	6217	24.9	249	2.05	24365
L89-113	7355	30.9	238	2.15	28797
$MSD_{.05}$	NS	11.4	21	0.20	NS

Table 7. 1994 second ratoon means of the 1989 "L" & "CP" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	7355	31.1	237	2.25	27561
CP70-321	6200	24.6	253	2.00	24550
CP74-383	8346	36.1	232	2.45	29530
L89-113	8336	35.1	239	1.95	35667
HoCP89-843	10649	40.6	263	2.05	39125
HoCP89-846	12835	43.5	295	1.95	44687
Ho89-889	10386	37.7	275	2.20	34384
$MSD_{.05}$	3395	15.6	23	0.40	9498

Table 8. 1994 second ratoon means of the 1989 "L" & "CP" series across locations[1].

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	7919	30.8	258	2.15	28823
CP70-321	6924	28.8	242	2.03	28362
CP74-383	7522	33.1	227	2.29	28915
L89-113	8061	33.5	241	1.88	35572
HoCP89-843	9371	37.9	246	1.96	38407
HoCP89-846	10220	37.5	268	1.82	41334
Ho89-889	9377	35.0	267	2.14	32723
$MSD_{.05}$	NS	NS	NS	0.20	8338

[1]Ardoyne Farm and St. Gabriel Commerce silt loam.

Table 9. 1994 second ratoon means of the 1989 "L" series across locations[1].

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	7296	29.1	251	2.08	27987
CP70-321	6219	25.2	250	1.97	25397
CP74-383	7087	30.4	234	2.21	27398
L89-113	7826	32.6	240	1.97	33313
$MSD_{.05}$	NS	NS	NS	NS	5362

[1]Ardoyne Farm, St. Gabriel Sharkey clay Commerce silt loam.

Table 10. 1994 second ratoon means of the 1990 "CP" series at Ardoyne Farm.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP65-357	6596	25.1	263	1.96	25554	13.5
CP70-321	7113	30.0	238	2.12	28292	----
CP74-383	7062	31.4	225	1.97	32568	----
HoCP90-923	9589	36.0	267	1.72	41926	12.1
HoCP90-941	7810	31.4	249	2.45	25658	11.4
HoCP90-957	8770	30.5	288	1.80	33964	11.7
HoCP90-963	7135	27.1	263	1.87	29004	13.1
HoCP90-977	6545	25.5	257	1.93	26498	15.8
$MSD_{.05}$	808	3.8	13	0.40	6869	2.1

Table 11. 1994 first ratoon means of the 1990 "CP" series at Ardoyne Farm.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP65-357	7778	27.8	280	2.18	25581	14.1
CP70-321	8934	33.8	265	2.34	28818	----
CP72-370	9615	34.5	278	2.08	33157	----
CP74-383	7324	30.2	243	2.58	23600	----
LCP82-089	8242	31.2	264	2.41	26082	----
HoCP90-923	9676	35.6	272	1.74	41057	12.0
HoCP90-941	9084	34.3	265	2.73	25190	12.3
HoCP90-957	9359	31.4	298	1.92	33256	11.7
HoCP90-963	8883	31.2	284	2.07	30136	13.6
HoCP90-977	7730	27.5	282	1.92	28675	14.9
$MSD_{.05}$	2112	6.3	29	0.50	8187	1.5

Table 12. 1994 first ratoon means of the 1990 "CP" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP70-321	7903	27.6	286	2.25	24593
CP74-383	5997	23.4	256	1.95	23773
LCP82-089	9212	33.4	276	2.05	32560
HoCP90-923	8195	31.5	260	1.70	37264
HoCP90-941	5911	22.2	265	2.75	15940
HoCP90-957	6840	24.5	280	1.95	25045
HoCP90-963	8490	28.6	297	1.95	29284
HoCP90-977	8307	30.8	271	2.10	29286
$MSD_{.05}$	3566	13.4	17	0.50	9245

Table 13. 1994 first ratoon means of the 1990 "CP" series at the St. Gabriel Research Station on a Commerce silt loam.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP70-321	8826	32.6	272	2.65	24519
CP74-383	9108	36.5	250	2.85	25663
LCP82-089	10478	38.4	274	2.50	30680
HoCP90-923	10163	39.3	259	1.85	42521
HoCP90-941	10427	40.4	258	3.40	23872
HoCP90-957	9402	32.3	292	2.35	27702
HoCP90-963	11490	40.1	286	2.40	33469
HoCP90-977	10478	37.4	280	2.25	33206
$MSD_{.05}$	2226	8.5	35	0.60	5369

Table 14. 1994 first ratoon means of the 1990 "CP" series across locations[1].

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP70-321	8554	31.3	274	2.41	25976
CP74-383	7476	30.0	249	2.46	24345
LCP82-089	9310	34.3	271	2.32	29774
HoCP90-923	9344	35.5	264	1.76	40281
HoCP90-941	8474	32.3	263	2.96	21667
HoCP90-957	8533	29.4	290	2.07	28667
HoCP90-963	9621	33.3	289	2.14	30963
HoCP90-977	8838	31.9	278	2.09	30389
$MSD_{.05}$	1968	NS	13	0.30	4905

[1]Ardoyne Farm, St. Gabriel Sharkey clay and Commerce silt loam.

Table 15. 1994 first ratoon means of the 1991 "CP" series at Ardoyne Farm.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP65-357	9364	34.2	274	2.18	31634	13.2
CP70-321	9263	34.7	267	2.31	30080	----
CP74-383	7869	29.9	263	2.20	27268	----
LCP82-089	9669	34.5	280	2.10	33141	----
HoCP91-527	12052	39.3	307	2.16	36764	13.8
HoCP91-534	9987	33.5	299	2.20	30485	15.3
HoCP91-542	8598	33.5	257	2.65	25308	12.1
HoCP91-552	9636	32.9	293	1.83	35901	15.3
HoCP91-555	11226	37.2	302	1.83	41647	13.8
HoCP91-559	8476	31.2	272	2.33	26847	15.5
HoCP91-566	10990	40.2	274	2.08	38655	16.0
$MSD_{.05}$	2169	8.2	11	0.40	14251	0.5

Table 16. 1994 first ratoon means of the 1991 "L" series at the St. Gabriel Research Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP70-321	6971	25.4	276	2.10	24191
CP74-383	6889	26.3	263	2.15	24774
LCP82-089	5770	21.0	276	2.05	20660
L91-250	6375	23.8	268	1.85	26057
L91-281	8088	30.6	265	2.05	30493
L91-288	3279	12.4	264	1.60	15687
L91-290	5795	21.4	271	1.60	26804
$MSD_{.05}$	3018	12.7	NS	NS	11375

Table 17. 1994 plant cane means of the 1990 "CP" series at Ardoyne Farm.

Variety	Sucrose yields	Cane yields	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP65-357	8073	27.7	292	2.65	20916	11.9
CP70-321	8018	28.9	277	2.51	23063	----
CP74-383	6655	25.6	260	2.26	22700	----
LCP82-089	6518	23.4	280	2.44	19213	----
HoCP90-923	7576	26.6	285	1.71	31111	11.6
HoCP90-941	9071	30.9	294	2.75	22447	12.3
HoCP90-957	9091	28.5	319	1.96	29161	12.1
HoCP90-963	8014	26.3	305	2.43	21650	13.3
HoCP90-977	6217	22.1	282	2.36	19851	15.4
$MSD_{.05}$	2239	8.5	17	0.50	10216	1.5

Table 18. 1994 plant cane means of the 1991 "L" & "CP" series at Ardoyne Farm.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP65-357	9807	31.8	308	2.27	28019	13.6
CP70-321	7768	28.2	276	2.29	24798	12.5
CP74-383	8362	31.1	269	2.32	26995	----
LCP82-089	9637	32.2	300	2.36	27307	----
L91-250	10332	34.3	301	2.02	34064	14.2
L91-281	9732	34.5	283	2.33	29590	12.9
HoCP91-527	10684	34.0	314	2.00	34098	14.8
HoCP91-534	8113	27.3	298	2.22	24571	15.8
HoCP91-542	7428	27.1	275	2.08	26113	12.0
HoCP91-552	10293	35.0	295	1.84	38115	16.0
HoCP91-555	9118	29.1	313	2.10	28055	13.3
HoCP91-559	7845	27.2	289	2.39	22783	14.2
HoCP91-566	9839	36.2	272	2.05	35419	16.1
$MSD_{.05}$	1359	4.2	15	0.40	7435	1.1

Table 19. 1994 plant cane means of the 1992 "L" series at the St. Gabriel Reseach Station on a Sharkey clay.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number
	lbs/A	tons/A	lbs/ton	lbs	no/A
CP65-357	7191	31.8	226	2.65	24262
CP70-321	8053	31.6	255	2.80	22536
LCP82-089	9684	37.6	258	2.60	29077
LHo92-307	7631	32.2	238	3.10	20779
L92-310	6928	29.7	234	3.35	17698
L92-312	8298	33.4	249	2.40	27834
L92-313	7618	33.7	226	2.75	24502
LHo92-314	9675	38.0	255	2.40	31673
L92-315	8128	32.4	251	2.30	28038
L92-319	6615	25.1	262	3.25	15339
L92-321	9368	37.1	252	3.20	23157
L92-355	8275	30.8	269	2.35	26218
$MSD_{.05}$	2109	7.3	31	0.30	4288

Table 20. 1994 plant cane means of the 1992 "CP" series at Ardoyne Farm.

Variety	Sucrose yield	Cane yield	Sucrose content	Stalk weight	Stalk number	Fiber
	lbs/A	tons/A	lbs/ton	lbs	no/A	%
CP83-899	13262	44.5	298	2.74	32593	113.0
CP83-625	10537	35.0	301	2.69	26512	14.1
CP65-357	9660	32.4	297	2.52	25663	13.5
CP70-321	9322	35.0	267	2.29	30505	----
CP74-383	8319	32.5	255	2.57	25520	----
LCP82-089	9219	32.6	283	2.22	29494	----
HoCP92-607	9304	33.3	278	2.52	26379	14.4
HoCP92-614	8088	30.5	266	1.92	31969	13.6
HoCP92-618	9071	30.2	301	2.16	28454	14.1
HoCP92-624	10407	35.4	294	2.20	32632	13.7
HoCP92-629	8868	31.0	287	2.45	25262	14.2
HoCP92-631	8901	29.6	301	2.34	25418	14.7
HoCP92-644	9453	32.7	290	2.10	31110	14.5
HoCP92-645	7841	28.8	273	1.97	29307	12.7
HoCP92-648	8968	30.8	291	2.28	27014	11.7
HoCP92-654	8924	33.1	270	2.29	29247	13.5
HoCP92-657	8014	32.5	246	2.28	28573	11.6
HoCP92-663	7674	25.8	298	1.98	26023	11.8
HoCP92-664	10045	34.2	294	1.90	37290	14.1
HoCP92-674	10467	34.5	303	2.28	30604	12.7
HoCP92-675	12020	39.0	308	2.82	27849	12.0
HoCP92-676	9718	34.7	280	2.67	25977	13.4
HoCP92-678	9625	32.9	293	2.25	29246	14.4
$MSD_{.05}$	1625	4.7	20	0.60	14035	1.3

1994 OUTFIELD VARIETY TRIALS[1]

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The purpose of the outfield variety trials is to test and identify experimental varieties that reliably produce high yields and are suitable for mechanical harvesting in the Louisiana sugarcane growing region. These trials are cooperatively conducted at 10 commercial locations throughout the Louisiana sugarcane belt by the Louisiana Agricultural Experiment Station, the United States Department of Agriculture - Agricultural Research Service, and the American Sugar Cane League.

The criteria for a successful variety require good performance with regard to yield and harvestability across locations, crops, and years relative to commercial varietal responses. Accurate varietal evaluation requires overall yield performance information in addition to close scrutiny of performance under adverse harvest conditions. The objective of this report is to provide overall and specific location yield data by crop for 1994 outfield tests. Also included are two- and three-year yield analyses for appropriate test varieties.

A randomized complete block design with three replications was used at each location. Plots were three rows wide (6-foot centers) and 32 feet long with 5-foot gaps between plot ends. All trials were harvested mechanically, separated by hand, and then weighed with a tractor-mounted hydraulic weigh rig. A 15-stalk sample was taken from each plot and sent to the USDA sucrose lab. The samples were weighed then milled to obtain juice for analysis.

Cane yield for each plot was estimated by plot weight less 14% to adjust for leaf-trash weight. Stalk number was calculated by dividing plot weight by stalk weight. All calculations for stalk number per acre and cane yield assumed 36-foot long plots. These two adjustments for plot length and trash weight adjusted downward cane yields, sucrose yields, and stalk number estimates by 26%.

Interpreting one-year yield data can be misleading since performance is biased by genotype by year interactions. Across location means can likewise be misleading since a variety,

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[1]The data for this report were obtained through a cooperative effort of personnel from the Louisiana Agricultural Experiment Station - LSUAC, USDA - Agricultural Research Service, Sugarcane Research Unit, and the American Sugar Cane League in accordance to the provisions of the "Three-way Agreement of 1978." The testing program would not be possible without the full cooperation of the growers at each outfield location.

This project was partiallly funded by the American Sugar Cane League.

experimental or commercial, may not consistently perform at all locations, and this inconsistency may not be clearly indicated in the overall mean. Multi-year and -location testing attempts to solve these problems.

A simple statistic has been included to aid in interpreting a variety's performance relative to other varieties in the test. This statistic is the percentage of the test locations at which a variety was not significantly (NS) different from the best yielding variety at a specific location. Although the best yielding variety at a location may vary, the "percent best" statistic indicates the percent of the tests a variety was in the best yield group. A variety with an 80% NS from best value was in the highest yielding group in 80% of the tests. This statistic intrisically places more value on more precise tests and helps the reader avoid making incorrect interpretations of the results due to minor differences in mean values. The statistic also provides a better understanding of varietal yield stability across locations than does the overall mean.

Analysis of variance was performed for each crop and location combination. A combined analysis was performed over locations within each crop. Minimum significant differences (MSD) were calculated by the Waller-Duncan multiple range test (SAS, 1985).

Seventeen experimental varieties were introduced to the outfield locations for seed increase, and 11 experimental and six commercial varieties were planted at 10 outfield locations in 1994 (Table 1). Outfield personnel harvested 10 plant-cane, 10 first ratoon, and 8 second ratoon tests (Table 2).

Varietal yields are reported by crops and trait with overall means and individual location data in the same table (tables 3-17). Combined analysis among 1992 through 1994 plant-cane crops (Table 18), first ratoon crops (Table 19), and second ratoon crops (Table 20), and 1993 through 1994 plant-cane crops (Table 21) and second ratoon crops (Table 22) are included to aid in the evaluation of the newest commercial variety, LCP86-454, and the most advanced experimental variety, HoCP88-739.

The harvestability of a sugarcane variety in Louisiana is affected by the erectness and the brittleness of the variety in interaction with the conditions under which it was grown and harvested (weather, row profile, type and condition of the harvester, and skill of the harvester operator). The harvestability of experimental varieties can be observed under a wide range of conditions in the outfield stage of the variety testing program and is an important function of the tests.

Harvestability is subjectively evaluated by documenting the condition of the test field at the time of harvest. As the test field is cut, the outfield agronomists note the erectness of each variety for which yield data will be taken. The heap row is then subjectively rated for scrappiness or the amount of cane left in the plot. The scrappiness rating is summarized in Table 23 for the three crops harvested in 1994.

References:

SAS Institute, Inc. 1985. SAS User's Guide:Basics, version 5 ed. SAS Institute, Cary, H.C.

Table 1. Varieties planted in the outfield in 1994.

Commercial Varieties	Experimental Varieties		Varieties Introduced to the Outfield	
CP65-357	HoCP88-739	HoCP90-963	HoCP89-846	L92-313
CP70-321	L89-113	HoCP90-977	Ho89-889	LHo92-314
CP72-370	HoCP89-843	L91-250	HoCP91-527	L92-315
LHo83-153	HoCP90-923	L91-281	HoCP91-542	L92-319
LCP85-384	HoCP90-941	HoCP91-552	HoCP91-555	L92-321
HoCP85-845	HoCP90-957		HoCP91-556	L92-355
			HoCP91-559	HoCP92-645
			LHo92-307	HoCP92-674
			L92-310	HoCP92-675
			L92-312	

Table 2. Plant-cane, first ratoon, and second ratoon harvest and planting dates for all outfield locations harvested in 1994.

		Plant-cane		First ratoon		Second ratoon	
Location	1994 Plant Date	1994 Harvest Date	1993 Plant Date	1994 Harvest Date	1993 Harvest Date	1994 Harvest Date	1993 Harvest Date
Allain	09/30	11/01	10/05	11/01	11/30	10/26	10/26
Bon Secour	09/13	11/30	09/30	11/30	12/03	10/18	11/03
Evan Hall						11/15	11/22
Georgia	10/04	12/01	08/25	12/01	12/13	10/19	11/08
Glenwood	09/28	12/05	09/17	11/03	12/02	10/27	11/02
Lanaux	09/22	12/02	09/02	11/07	12/06	10/19	11/04
Levert-St.J.	09/20	11/17	09/08	11/08	12/01	10/24	11/17
Magnolia	09/27	11/28	10/07	11/28	11/23		
Oaklawn	09/29	10/31	08/27	10/31			
Palo Alto	09/23	11/02	09/29	11/02	11/29		
R. Hebert	09/26	11/22	09/17	11/09	12/01	10/25	11/01

Table 3. Plant-cane sucrose yields (lbs./A) for eight commercial and three experimental varieties at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	6660	7808	----	5703	8104	6456	----	6753	7308	7844	7080	50
CP70-321	6337	7862	5219	5937	6229	6669	6382	6470	6923	6400	6442	30
CP72-370	6094	8345	----	6790	7925	7214	7447	6170	7420	6034	7094	56
LCP82-089	6963	7742	5827	7056	7368	7183	5533	8033	8486	7008	7073	40
LHo83-153	6423	7229	4525	----	6769	7585	6582	8305	7202	7133	6862	56
LCP85-384	7305	7815	6800	8562	7875	7750	7400	8207	8485	8844	7910	100
HoCP85-845	6125	8613	5273	----	8548	8827	6841	7747	7765	7306	7411	78
LCP86-454	6509	6456	5529	6299	6791	7598	6981	8101	6592	7052	6791	40
HoCP88-739	5985	8660	5112	6564	6931	8189	6597	7314	7308	----	6962	56
L89-113	6731	7761	4233	6049	7297	7076	7329	7924	8475	7147	7002	50
HoCP89-843	6525	7903	3477	6878	7776	6954	7088	8002	8619	7452	7068	60
Mean	6514	7836	5111	6643	7384	7399	6818	7627	7664	7219	7059	50
$MSD_{.05}$	1354	1126	814	851	1044	1312	1766	983	1595	854	601	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 4. Plant-cane yield of cane (tons/A) for eight commercial and three experimental varieties at ten outfield locations in 1994.

	Heavy textured soil locations				Light texured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	27.8	33.4	----	28.5	28.1	24.7	----	25.9	26.8	29.2	28.1	38
CP70-321	26.0	31.6	21.3	25.6	22.9	24.8	25.1	26.2	26.1	24.8	25.4	20
CP72-370	25.6	32.2	----	27.7	30.7	26.7	29.7	26.6	27.0	23.5	27.8	44
LCP82-089	27.9	33.9	25.4	29.4	28.3	28.3	22.5	30.3	30.8	26.3	28.2	50
LHo83-153	27.8	30.4	19.0	----	26.3	29.6	27.5	31.7	28.3	29.0	27.7	56
LCP85-384	29.0	31.0	26.0	34.2	28.3	27.9	29.1	30.6	30.9	31.1	29.9	70
HoCP85-845	26.8	35.2	21.7	----	34.8	33.2	30.3	32.9	30.0	28.9	30.3	78
LCP86-454	26.0	29.7	24.7	31.8	27.4	29.1	31.0	32.8	24.3	30.2	28.7	50
HoCP88-739	22.0	31.0	18.2	27.2	23.3	26.6	22.6	25.6	25.8	----	24.7	0
L89-113	27.3	32.0	17.2	26.7	29.2	27.7	28.8	30.4	30.2	27.8	27.7	50
HoCP89-843	26.5	34.3	14.7	30.5	32.0	25.8	27.9	31.0	32.0	32.1	28.7	70
Mean	26.6	32.2	20.9	29.1	28.1	27.7	27.4	29.7	28.3	28.3	27.9	50
$MSD_{.05}$	3.4	4.0	2.9	1.9	2.8	3.8	3.6	3.3	5.8	2.6	2.1	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 5. Plant-cane sucrose content (lbs./ton) for eight commercial and three experimental varieties at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	239	234	---	200	288	261	---	260	274	268	253	38
CP70-321	244	249	244	232	272	269	255	247	265	258	254	10
CP72-370	238	259	---	245	258	270	251	232	275	257	255	22
LCP82-089	250	228	230	240	260	253	246	265	275	266	251	30
LHo83-153	231	238	238	---	257	257	239	262	255	246	247	0
LCP85-384	252	253	262	250	279	278	254	268	274	284	265	40
HoCP85-845	228	245	243	---	246	266	227	236	259	253	244	0
LCP86-454	250	217	223	198	248	262	225	247	272	234	238	10
HoCP88-739	272	280	280	241	297	308	293	286	283	---	282	100
L89-113	247	242	246	226	250	255	255	260	281	257	252	20
HoCP89-843	246	231	235	225	242	269	255	258	270	232	246	10
Mean	245	243	244	228	264	268	250	258	271	256	253	20
$MSD_{.05}$	17	18	18	24	17	26	36	17	17	22	9	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P<0.05$).

Table 6. Plant-cane stalk number (no./A) for eight commercial and three experimental varieties at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	17929	21260	-----	23660	20655	19645	-----	16943	19419	24408	20490	25
CP70-321	19400	19444	19977	18880	19477	24796	19376	21039	19998	20746	20288	30
CP72-370	19570	21237	-----	21657	23612	22672	20335	21709	20831	18200	20415	44
LCP82-089	20843	22001	21779	24777	21739	23189	18158	23212	23527	25005	22385	50
LHo83-153	21654	23976	18634	-----	21234	24372	21601	24820	21069	22442	22200	67
LCP85-384	23113	21177	29542	29714	24427	25923	24440	23522	24152	24427	25013	90
HoCP85-845	22243	24977	23769	-----	27603	28302	21617	23544	23179	23916	24237	89
LCP86-454	18989	16352	18577	19197	15828	16907	17349	17485	14138	18771	17359	0
HoCP88-739	16265	20714	18987	20301	18169	22166	16028	17512	19732	-----	18875	11
L89-113	19730	21250	17709	24042	23446	22643	22004	21720	26424	23661	22263	60
HoCP89-843	22322	21860	14245	21276	24230	21759	19617	23647	23397	22808	21516	50
Mean	20187	21295	20358	22648	21677	22850	20053	21378	21377	22387	21358	50
$MSD_{.05}$	3714	4432	3307	3319	2824	4805	4411	5094	3746	2875	1720	

[1] All.-A.V. Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 7. Plant-cane stalk weights (lbs.) for eight commercial and three experimental varieties at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	3.10	3.17	----	2.40	2.73	2.57	----	3.07	2.80	2.40	2.78	13
CP70-321	2.70	3.27	2.13	2.73	2.33	2.00	2.60	2.50	2.63	2.40	2.53	0
CP72-370	2.60	3.00	----	2.55	2.60	2.37	2.93	2.45	2.60	2.57	3.02	0
LCP82-089	2.70	3.10	2.33	2.40	2.60	2.47	2.47	2.63	2.65	2.13	2.54	0
LHo83-153	2.57	2.57	2.07	----	2.47	2.43	2.57	2.53	2.73	2.60	2.50	0
LCP85-384	2.53	2.93	1.80	2.30	2.30	2.20	2.40	2.63	2.57	2.57	2.43	0
HoCP85-845	2.43	2.80	1.83	----	2.50	2.33	2.83	2.80	2.60	2.45	2.51	0
LCP86-454	2.77	3.60	2.67	3.30	3.47	3.43	3.57	3.77	3.40	3.20	3.32	90
HoCP88-739	2.70	3.03	1.93	2.70	2.57	2.40	2.83	2.93	2.63	----	2.64	0
L89-113	2.77	3.00	1.93	2.23	2.47	2.47	2.63	2.83	2.30	2.37	2.50	0
HoCP89-843	2.40	3.17	2.07	2.87	2.67	2.37	2.90	2.67	2.73	2.80	2.66	0
Mean	2.66	3.06	2.09	2.61	2.61	2.47	2.77	2.82	2.70	2.55	2.64	0
$MSD_{.05}$	0.29	0.31	0.26	0.33	0.34	0.35	0.34	0.50	0.45	0.39	0.15	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 8. First ratoon sucrose yields (lbs./A) for nine commercial and one experimental variety at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	4446	8022	4002	5651	6799	6167	6313	5762	6611	8320	6209	20
CP70-321	4824	7485	4516	5650	6530	6685	6190	5279	6116	8314	6195	30
CP72-370	4643	6319	4561	6640	7689	6931	6493	6038	7013	7644	6397	20
CP74-383	3952	7583	4976	----	6867	6169	5414	6898	7349	7892	6245	33
LCP82-089	4269	7881	5269	7700	7007	6428	6267	5355	9070	7962	6687	40
LHo83-153	4973	5816	4380	7242	6344	6740	7432	5826	8493	8881	6640	30
LCP85-384	5082	----	5314	9327	8237	7871	9319	7433	6525	9393	7611	89
HoCP85-845	5184	6248	4030	8139	8550	8016	6753	6583	6912	9194	6961	60
LCP86-454	5096	7986	4512	7594	6854	6115	6887	7386	7662	9272	6936	50
HoCP88-739	5461	7302	5662	7243	8165	7332	6980	7303	8068	----	7057	78
Mean	4793	7151	4722	7357	7304	6845	6805	6406	7382	8541	6692	50
$MSD_{.05}$	844	1160	915	2019	874	949	1828	1122	1285	1120	646	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P<0.05$).

Table 9. First ratoon yield of cane (tons/A) for nine commercial and one experimental variety at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	16.2	26.3	15.4	21.3	24.0	22.2	28.6	24.1	23.9	30.9	23.3	10
CP70-321	18.1	25.9	17.3	22.2	23.5	24.3	26.9	22.0	22.5	32.0	23.6	30
CP72-370	17.5	22.5	17.2	25.0	28.7	24.4	25.7	24.6	25.6	29.9	24.1	20
CP74-383	14.5	25.8	19.9	----	26.1	25.2	25.7	30.2	28.6	33.2	25.5	33
LCP82-089	15.6	26.3	20.7	29.7	25.5	24.5	26.1	22.0	32.9	31.3	25.3	40
LHo83-153	18.6	20.2	17.6	29.4	23.3	25.1	31.4	23.4	30.9	35.9	25.6	50
LCP85-384	18.7	----	20.2	33.1	28.2	26.9	36.4	29.4	22.5	33.2	27.6	56
HoCP85-845	20.0	21.8	16.6	30.5	32.6	29.5	29.1	27.2	26.5	36.0	27.0	50
LCP86-454	18.9	27.6	18.9	30.5	26.9	23.6	29.1	31.3	27.5	38.9	27.3	60
HoCP88-739	18.3	23.6	19.5	26.5	26.7	24.3	25.3	27.0	27.0	----	24.2	33
Mean	17.7	24.4	18.3	27.9	26.5	25.0	28.4	26.2	26.8	33.5	25.4	40
$MSD_{.05}$	3.0	3.6	3.7	6.8	3.2	2.3	4.5	2.5	4.2	3.0	2.5	

[1] All.-A.V. Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 10. First ratoon sucrose content (lbs./ton) for nine commercial and one experimental variety at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	273	305	260	265	283	278	221	240	277	270	267	50
CP70-321	266	288	262	254	279	275	230	240	273	260	263	30
CP72-370	266	281	266	266	268	284	251	245	274	256	266	50
CP74-383	272	294	250	---	262	245	210	230	257	238	248	11
LCP82-089	272	300	255	259	275	263	240	242	276	255	264	40
LHo83-153	267	287	250	246	273	268	237	249	275	247	260	20
LCP85-384	271	---	262	282	292	292	254	254	289	283	276	78
HoCP85-845	259	286	241	268	262	271	233	243	262	255	258	20
LCP86-454	269	289	239	249	256	259	236	235	279	238	255	20
HoCP88-739	298	309	291	273	306	302	276	270	298	---	292	100
Mean	271	293	258	263	276	274	239	245	276	256	265	30
$MSD_{.05}$	13	9	17	28	18	21	29	99	28	17	6	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 11. First ratoon stalk numbers (no./A) for nine commercial and one experimental variety at ten outfield locations in 1994.

Variety	Heavy textured soil locations				Light textured soil locations						Mean	NS from best[2]
	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.		
CP65-357	15291	22345	17765	20573	20090	19828	27045	18948	21054	25143	20808	10
CP70-321	17837	21642	21081	19763	23980	19548	26505	16499	23639	28132	22012	20
CP72-370	18146	18726	18106	23327	26228	20985	23103	20656	25573	22653	21750	20
CP74-383	18221	23021	20779	-----	23951	23831	20046	24405	26124	29680	23365	33
LCP82-089	16675	22175	20854	30632	24177	22821	23369	18965	32473	25699	23548	20
LHo83-153	20380	20242	21597	28715	21520	22490	28723	20588	29644	27747	24288	40
LCP85-384	21962	-----	29311	39176	27234	27195	35465	29768	26176	29322	29512	89
HoCP85-845	19754	19944	23324	26526	28909	26487	25355	21307	27996	29791	24939	60
LCP86-454	18239	20771	17966	23543	17718	16499	22511	19703	20769	24535	20225	10
HoCP88-739	19694	20177	20488	25082	23110	22878	24011	21562	27279	-----	22698	22
Mean	18620	20844	21127	26744	23692	22256	25613	21263	26073	26967	23260	20
$MSD_{.05}$	2584	4722	4368	6880	4386	3535	5492	2053	4568	3914	2162	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 12. First ratoon stalk weights (lbs.) for nine commercial and one experimental variety at ten outfield locations in 1994.

	Heavy textured soil locations				Light textured soil locations							
Variety	All.[1]	Mag.	Oak.	P.A.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	2.13	2.37	1.77	2.07	2.40	2.23	2.10	2.57	2.27	2.43	2.23	20
CP70-321	2.03	2.40	1.63	2.20	1.97	2.57	2.07	2.70	1.87	2.33	2.18	20
CP72-370	1.93	2.40	1.87	2.17	2.20	2.37	2.23	2.40	2.00	2.63	2.22	40
CP74-383	1.60	2.20	1.90	----	2.20	2.13	2.63	2.47	2.20	2.23	2.17	22
LCP82-089	1.87	2.37	2.00	1.95	2.10	2.17	2.23	2.30	2.00	2.43	2.15	30
LHo83-153	1.83	2.03	1.63	2.07	2.17	2.23	2.17	2.30	2.10	2.57	2.10	20
LCP85-384	1.70	----	1.37	1.70	2.10	2.00	2.03	1.97	1.73	2.27	1.87	0
HoCP85-845	2.03	2.20	1.47	2.30	2.27	2.23	2.27	2.53	1.97	2.43	2.17	30
LCP86-454	2.10	2.67	2.10	2.67	3.03	2.87	2.57	3.13	2.67	3.17	2.70	10
HoCP88-739	1.87	2.37	1.90	2.10	2.30	2.13	2.10	2.53	2.00	----	2.14	22
Mean	1.91	2.34	1.76	2.14	2.27	2.29	2.24	2.50	2.08	2.50	2.20	20
$MSD_{.05}$	0.31	0.27	0.23	0.43	0.25	0.23	0.46	0.18	0.45	0.26	0.13	

[1] All.-A.V.Allain & Sons, Mag.-Magnolia, Oak.-Oaklawn, P.A.-Palo Alto, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.

[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 13. Second ratoon sucrose yields (lbs./A) for ten commercial varieties at eight outfield locations in 1994.

	Heavy textured soil locations		Light textured soil locations							
Variety	All.[1]	E.H.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	2713	5530	4740	4417	2787	4836	4948	6094	4508	0
CP70-321	2846	6322	3206	4346	3610	3185	4988	5746	4281	13
CP72-370	4360	7013	4732	4312	3724	3381	5817	4827	4673	13
CP74-383	4397	6575	4476	4321	3738	5208	5794	5560	5009	13
CP79-318	4479	6948	5864	6554	4056	5733	5794	6442	5681	25
LCP82-089	4539	6656	6107	4805	4635	6109	4847	5506	5400	13
LHo83-153	4157	7254	3737	4402	4631	4038	6124	5722	5035	25
LCP85-384	5730	7902	7586	7104	6219	9015	7633	8149	7417	100
HoCP85-845	4905	7045	6242	6362	4007	7678	6495	7045	6222	63
LCP86-454	3632	7288	3585	5242	4773	5635	5830	5977	5245	25
Mean	4176	6844	5027	5213	4218	5482	5827	6107	5350	13
$MSD_{.05}$	846	1792	1054	977	1456	1038	1637	1437	632	

[1] All.-A.V.Allain & Sons, E.H. -Evan Hall, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.
[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P<0.05$).

Table 14. Second ratoon yield of cane (tons/A) for ten commercial varieties at eight outfield locations in 1994.

	Heavy textured soil locations		Light textured soil locations							
Variety	All.[1]	E.H.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	9.7	19.1	19.6	20.0	13.7	21.1	20.2	24.3	18.5	0
CP70-321	10.8	21.7	13.4	20.5	15.3	15.1	19.5	23.7	17.5	13
CP72-370	15.4	24.4	18.5	19.8	15.4	15.6	21.8	21.0	18.7	25
CP74-383	16.8	24.4	21.0	22.5	16.7	25.3	24.4	24.9	22.0	25
CP79-318	15.5	23.5	23.8	26.3	17.0	24.8	21.5	25.3	22.2	63
LCP82-089	16.4	23.0	24.7	23.5	20.8	26.5	19.2	25.1	22.4	50
LHo83-153	15.9	26.5	16.6	22.9	20.4	21.3	23.8	25.7	21.6	50
LCP85-384	20.2	26.8	28.1	30.0	25.1	35.0	27.3	30.8	27.9	100
HoCP85-845	17.6	24.7	26.2	28.8	16.5	33.7	24.7	28.9	25.1	88
LCP86-454	13.1	25.6	16.2	24.4	19.7	26.2	22.9	27.8	22.0	50
Mean	15.1	24.0	20.8	23.9	18.0	24.5	22.5	25.7	21.8	38
$MSD_{.05}$	3.0	6.5	4.3	4.0	6.5	3.7	6.0	5.8	2.3	

[1] All.-A.V.Allain & Sons, E.H. -Evan Hall, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.
[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P<0.05$).

Table 15. Second ratoon sucrose content (lbs./ton) for ten commercial varieties at eight outfield locations in 1994.

	Heavy textured soil locations		Light textured soil locations							
Variety	All.[1]	E.H.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	280	290	241	221	204	229	245	251	245	50
CP70-321	264	291	236	212	235	211	256	242	243	38
CP72-370	283	288	256	217	242	218	267	229	248	63
CP74-383	261	269	213	192	224	206	241	224	229	0
CP79-318	289	296	246	250	239	232	271	254	258	88
LCP82-089	277	290	248	204	223	230	253	219	243	38
LHo83-153	261	274	227	193	228	190	256	222	233	13
LCP85-384	283	296	269	237	248	258	282	265	267	100
HoCP85-845	279	286	238	220	245	228	263	244	250	50
LCP86-454	278	285	219	216	243	213	256	216	241	38
Mean	276	286	239	217	233	221	259	237	246	38
$MSD_{.05}$	10	19	21	18	18	29	28	19	9	

[1] All.-A.V.Allain & Sons, E.H. -Evan Hall, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.
[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P<0.05$).

Table 16. Second ratoon stalk numbers (no./A) for ten commercial varieties at eight outfield locations in 1994.

	Heavy textured soil locations		Light textured soil locations							
Variety	All.[1]	E.H.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	13311	17944	19593	21818	16376	19068	20291	24550	19119	0
CP70-321	15097	22690	16453	19795	20638	14636	22076	24680	19508	0
CP72-370	21231	28555	20248	20532	18365	15348	26949	23908	21602	0
CP74-383	23557	24936	23228	22558	20323	26051	27540	29123	24665	0
CP79-318	21862	26327	22338	24890	18348	21503	25298	22940	22791	0
LCP82-089	24965	24552	27079	24042	26857	26973	22739	24587	25224	0
LHo83-153	23428	31151	19538	24001	27733	23856	29594	28500	26061	13
LCP85-384	33047	35881	31978	34779	36769	37646	38733	38482	35915	100
HoCP85-845	29509	27453	27866	28664	24441	30737	29747	31447	28733	25
LCP86-454	16874	24734	13825	19122	21405	18758	19593	20790	19388	0
Mean	22288	26349	22215	24021	23126	23458	26256	26901	24311	0
$MSD_{.05}$	4878	7133	4460	3934	8260	3495	7602	6845	2331	

[1] All.-A.V.Allain & Sons, E.H. -Evan Hall, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.
[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P < 0.05$).

Table 17. Second ratoon stalk weights (lbs.) for ten commercial varieties at eight outfield locations in 1994.

	Heavy textured soil locations		Light textured soil locations							
Variety	All.[1]	E.H.	B.S.	Geo.	Gln.	Lan.	R.H.	StJ.	Mean	NS from best[2]
CP65-357	1.47	2.17	2.03	1.83	1.70	2.23	2.00	2.00	1.93	38
CP70-321	1.40	1.93	1.67	2.07	1.43	2.07	1.80	1.93	1.79	25
CP72-370	1.43	1.70	1.83	1.90	1.67	2.03	1.60	1.77	1.74	25
CP74-383	1.43	1.93	1.80	1.97	1.67	1.93	1.73	1.73	1.78	38
CP79-318	1.40	1.80	2.13	2.10	1.87	2.30	1.77	2.20	1.95	38
LCP82-089	1.33	1.87	1.87	1.97	1.53	1.97	1.73	2.03	1.79	25
LHo83-153	1.40	1.67	1.67	1.90	1.50	1.77	1.60	1.80	1.65	13
LCP85-384	1.23	1.50	1.77	1.70	1.37	1.87	1.40	1.60	1.55	13
HoCP85-845	1.20	1.80	1.90	2.00	1.40	2.20	1.67	1.87	1.75	13
LCP86-454	1.53	2.10	2.33	2.53	1.87	2.80	2.37	2.67	2.28	100
Mean	1.38	1.85	1.90	2.00	1.60	2.12	1.77	1.96	1.82	25
$MSD_{.05}$	0.35	0.36	0.21	0.24	0.21	0.16	0.34	0.23	0.12	

[1] All.-A.V.Allain & Sons, E.H. -Evan Hall, B.S.-Bon Secour, Geo.-Georgia, Gln.-Glenwood, Lan.-Lanaux, R.H.-Ronald Hebert, StJ.-Levert-St. John.
[2] Percentage of locations where the variety was not significantly less than the highest yielding variety at that location as determined with the minimum significant difference ($P<0.05$).

Table 18. Combined plant-cane means across locations from 1992 through 1994.

Variety	Tests[1]	Sucrose yield		Cane yield		Sucrose content		Stalk number		Stalk weight	
		Mean	NS from best[2]	Mean	NS from best	Mean	NS from best	Mean	NS from best	Mean	NS from best
	no.	lbs/A	%	tons/A	%	lbs/ton	%	no./A	%	lbs.	%
CP65-357	30	6596	67	25.1	54	265	57	20109	23	2.5	23
CP70-321	31	6037	42	23.4	32	259	29	18869	13	2.5	19
CP72-370	31	6551	65	25.1	58	262	39	20363	35	2.5	13
LCP82-089	32	6280	50	24.4	50	259	41	19765	22	2.5	16
LHo83-153	31	6353	58	25.3	61	251	10	22442	58	2.3	0
LCP85-384	32	7212	94	26.6	78	272	75	23951	78	2.2	0
HoCP85-845	31	6763	77	26.9	81	252	10	22429	65	2.4	3
LCP86-454	32	6444	59	25.6	63	254	34	16736	3	3.1	97
$MSD_{.05}$		317		1.2		5		1045		.1	

[1] Number of tests in which the variety was harvested in 1992, 1993, and 1994.

[2] Percent of total tests the variety was not significantly different from the best variety for that trait in that test.

Table 19. Combined first ratoon means across outfield locations from 1992 through 1994.

Variety	Tests[1]	Sucrose yield		Cane yield		Sucrose content		Stalk number		Stalk weight	
		Mean	NS from best[2]	Mean	NS from best	Mean	NS from best	Mean	NS from best	Mean	NS from best
	no.	lbs/A	%	tons/A	%	lbs/ton	%	no./A	%	lbs.	%
CP65-357	31	5817	26	22.0	26	265	74	21338	13	2.1	32
CP70-321	32	5895	28	22.3	38	264	56	21704	13	2.1	38
CP72-370	32	6189	28	23.2	38	267	72	22742	16	2.0	34
CP74-383	31	6039	23	24.5	52	248	23	25365	42	1.9	23
LCP82-089	32	6281	31	23.9	44	264	63	24719	25	1.9	16
LHo83-153	31	6217	35	24.3	55	256	32	25590	42	1.9	23
LCP85-384	31	7667	94	27.9	84	276	90	31658	97	1.8	3
HoCP85-845	31	6353	42	24.9	52	256	39	25318	42	2.0	19
LCP86-454	32	6604	50	25.4	63	261	56	20478	6	2.5	100
$MSD_{.05}$		327		1.2		4		1242		0.1	

[1] Number of tests in which the variety was harvested in 1992, 1993, and 1994.

[2] Percent of total tests the variety was not significantly different from the best variety for that trait in that test.

Table 20. Combined second ratoon means across outfield locations from 1992 through 1994.

Variety	Tests[1]	Sucrose yield		Cane yield		Sucrose content		Stalk number		Stalk weight	
		Mean	NS from best[2]	Mean	NS from best	Mean	NS from best	Mean	NS from best	Mean	NS from best
	no.	lbs/A	%	tons/A	%	lbs/ton	%	no./A	%	lbs.	%
CP65-357	21	4877	24	19.6	19	250	86	21106	10	1.9	43
CP70-321	22	5062	27	20.2	32	248	59	21631	18	1.9	50
CP72-370	19	5092	16	20.2	26	251	74	22840	11	1.8	58
CP74-383	22	5427	32	23.5	50	233	18	26446	32	1.8	36
CP79-318	21	5735	48	22.9	57	253	95	24502	24	1.9	52
LCP82-089	22	5476	27	22.5	45	245	50	25752	18	1.8	41
LHo83-153	21	5479	38	22.9	52	239	43	27480	33	1.7	24
LCP85-384	22	7213	95	27.5	95	264	100	35236	95	1.6	18
HoCP85-845	21	6014	67	24.2	67	249	57	27880	33	1.7	29
$MSD_{.05}$		414		1.5		6		1819		0.1	

[1] Number of tests in which the variety was harvested in 1992, 1993, and 1994.

[2] Percent of total tests the variety was not significantly different from the best variety for that trait in that test.

Table 21. Two year second ratoon outfield means for 1993 and 1994.

Variety	Tests	Sucrose yield		Cane yield		Sucrose content		Stalk number		Stalk weight	
		mean	NS from† best	mean	NS from best	mean	NS from best	mean	NS from best	mean	NS from best
	no.	lbs/A	%	tons/A	%	lbs/ton	%	no./A	%	lbs.	%
CP65-357	16	4764	13	20.0	13	239	75	20967	7	1.9	44
CP70-321	17	4929	24	20.3	24	240	58	21480	6	1.9	35
CP74-383	17	5367	24	24.0	41	225	17	27147	23	1.8	24
LCP82-089	17	5478	18	23.3	41	236	41	26534	11	1.8	29
LHo83-153	16	5184	19	22.7	38	229	44	26834	13	1.7	19
LCP85-384	17	7303	94	28.5	94	258	100	36338	94	1.6	18
HoCP85-845	16	5911	57	24.4	57	242	63	27998	19	1.7	13
LCP86-454	17	5576	35	23.5	47	238	58	20666	11	2.3	100
$MSD_{0.05}$		485		1.7		7		2051		0.1	

† NS from best - Percent of tests that variety was not significantly less than the highest yielding variety in that test.

Table 22. Two year plant cane outfield means for 1993 and 1994.

Variety	Tests	Sucrose yield		Cane yield		Sucrose content		Stalk number		Stalk weight	
		mean	NS from† best	mean	NS from best	mean	NS from best	mean	NS from best	mean	NS from best
	no.	lbs/A	%	tons/A	%	lbs/ton	%	no./A	%	lbs.	%
CP65-357	18	6715	67	27.0	56	251	39	21149	28	2.6	22
CP70-321	19	6093	37	24.7	37	247	10	19737	16	2.5	16
CP72-370	19	6629	63	26.2	57	253	37	21160	52	2.5	10
LCP82-089	20	6410	40	26.0	45	247	35	20719	30	2.5	20
LHo83-153	19	6365	53	26.4	53	241	5	22637	58	2.4	0
LCP85-384	20	7150	90	27.2	65	263	60	24089	80	2.3	0
HoCP85-845	19	6811	44	28.2	74	242	5	23264	69	2.4	5
LCP86-454	20	6554	55	27.4	55	241	25	17463	5	3.2	95
HoCP88-739	18	6571	56	23.8	11	277	100	18558	6	2.6	22
$MSD_{0.05}$		454		1.7		7		1372		0.1	

† NS from best - Percent of tests that variety was not significantly less than the highest yielding variety in that test.

Table 23. Percentage of 1994 outfield plots in which each variety rated in the designated catagory of post-harvest scrap.

Variety	Crop†	None	Little	Some	Much	V. Much	Total Obs.
		----------	----------	% plots	----------	----------	no.
CP65-357	PC	100					24
	FR	100					30
	SR	88	8	4			24
	All	96	3	1			78
CP70-321	PC	100					29
	FR	100					28
	SR	92	8				24
	All	98	2				81
CP72-370	PC	100					25
	FR	100					30
	SR	91	4	4			23
	All	97	1	1			78
CP74-383	FR	100					25
	SR	96	4				24
	All	98	2				49
CP79-318	SR	61	9	13	9	9	23
LCP82-089	PC	100					29
	FR	100					29
	SR	92	8				24
	All	98	2				82
LHo83-153	PC	100					27
	FR	97					29
	SR	83	9	4	4		23
	All	94	4	1	1		79
LCP85-384	PC	100					29
	FR	96	4				27
	SR	83	4	4		8	24
	All	93	4	1		3	80
HoCP85-845	PC	100					25
	FR	100					30
	SR	100					24
	All	100					79
LCP86-454	PC	100					30
	FR	100					30
	SR	100					24
	All	100					84
HoCP88-739	PC	100					27
	FR	100					27
	All	100					54
L89-113	PC	100					30
HoCP89-843	PC	100					30

† PC - plant cane; FR - First ratoon; SR - second ratoon.

SUCROSE LABORATORY AT ST. GABRIEL

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Over 3,000 samples were processed at the St. Gabriel Sucrose Laboratory during the 1994 harvest season (Table 1). Standard laboratory procedures, which include use of the ABC Clarifier, were used to measure the sucrose content of the juice. The juice was extracted via a three-roller mill for most of the samples (2,967). Seventy-three samples were analyzed for fiber via chip/press extraction. The computer program used to record the pol and brix to computer files also calculated the sucrose, purity, and theoretical recoverable sugar (TRS) of each sample.

Table 1. Number of sugarcane samples processed at the St. Gabriel Sucrose Laboratory during the 1994 harvest season.

PROJECT AREA/LEADER	NUMBER OF SAMPLES
Cultural Practices and Fertility	
Ricaud	726
Hallmark	407
Viator	64
Selim	36
Entomology	28
Plant Pathology	82
Weed Science	249
Variety Program	
Infield	108
Line Trial	956
Nursery	311
Nursery (fiber)	73
TOTAL	3,040

This project was partially funded by the American Sugar Cane League.

IMPROVING SELECTION PROCEDURES IN SUGARCANE USING CROSS APPRAISAL METHODS

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SUMMARY

It was hypothesized that the use of family selection could be used to improve the selection efficiency of the first selection stage in the Louisiana Sugarcane Variety Development Program. Studies were conducted or are underway to measure the selection miss rate of this first stage and to evaluate the magnitude the family by environment interaction. Results suggest that an average of 3/4 of the clones acceptable in the first selection stage are not selected in the initial selection stage (Seedling stage). Initial results also suggest that family by environment interaction may not be important in estimating family performance values. Further evaluation suggests that between 172 to 220 families are necessary to maintain the population size of the first clonal trials, which is about the number of families currently planted. A lowering of the miss rate by advancing more progeny from each cross would enable the planting progeny of fewer, more select crosses.

INTRODUCTION

Genotype by environment (GE) interaction negatively affects selection in breeding programs. The actuality of family by environment interaction and its negative effects on selection is expected, but its presence and the magnitude of this interaction relative to the family error variance in Louisiana needs confirmation.

The objective of this study was to determine the magnitude of family by environment interaction in a Louisiana sugarcane breeding population. Additional goals were to estimate the minimum number of families that could provide enough individuals for the next selection stage and to estimate the potential miss rate of selections at this stage in the program.

Early selection stages of a breeding program commonly rely upon subjective evaluation at one or a few locations. Resource constraints usually delay replication among environments until later selection stages. The initial stage of the Louisiana Sugarcane Variety Development Program (LSVDP) uses visual appraisal to select among single plants at the St. Gabriel Research Station. Breeders are not perfect in their selection techniques. Research personnel express a tendency to lower selection standards in poorer crosses and raise them in better crosses. Interest has grown in family selection as a means to improve selection efficiency by averaging out some of the inherent errors of selecting among individuals. A measure of the potential miss rate at this initial stage was also of interest.

This project was partially funded by the American Sugar Cane League.

MATERIALS AND METHODS

In September 1992, to estimate the possible miss rate at the first selection stage, 20 individuals each from 25 crosses from the 1990 LAES crossing series were randomly selected and planted using a randomized complete block design with four replications at the St. Gabriel Research Station. Single- row plots were 4.8 m long with a 1.2-m space between plots. Total millable stalk number was determined on first ratoon cane in August 1994 on an individual plot basis. Stalk height was measured from the base to the top visible dewlap. Midstalk internode stalk diameter was measured with a caliper at the bud groove. In August 1994, two to four breeders gave subjective cane yield ratings for each plot. Stalk weight was estimated by assuming the stalk was a perfect cylinder with a specific gravity of one. Two stalks per plot were also cut and given an acceptability rating for pith.

In a second test, progeny from 45 biparental crosses were transplanted to a Commerce silt loam (fine-silty, mixed, nonacid, thermic Aeric Fluvaquent) at the St. Gabriel Research Station and to a Mhoon silt loam (fine-silty, mixed, nonacid, thermic, Typic Fluvaquent) at the Ardoyne Farm near Chacahoula, LA in April 1993. Both locations used a randomized complete block design with two blocks. Progeny from an additional 78 families were also replicated at St. Gabriel. Progeny from the crosses were planted in plots of paired rows 1.8 m apart using up to 16 plants per row. Each row was 4.8 m long with a 1.2-m space between plots and 40-cm intrarow plant spacing. Yield component data were collected in 1994 on first ratoon plants. Total millable stalk number and number of plants were determined on an individual row within plot basis. Stalk height and stalk diameter were determined from one stalk each from five plants within in each row, plot, block, and location for a total of 40 observations per cross. Stalk weight times stalks per plant gave estimates for plant weight. Plant weight was considered the individual plant equivalent of clonal plot cane yield. Data were analyzed according to the model:

$$Y_{m(kjil)} = \mu + L_i + B(L)_{j(i)} + X_k + XL_{ki} + XB(L)_{kj(i)} + R(XBL)_{l(kji)} + E_{m(kjil)}$$

where $Y_{m(kjil)}$ is plant m in cross k, block j, location i, and row l; μ is the overall mean; L_i is location i; $B(L)_{j(i)}$ is block j in location i; X_k is cross k; XL_{ki} is cross k by location i; $XB(L)_{kj(i)}$ is cross k by block j in location i; $R(XBL)_{l(kji)}$ is row l in cross k by block j and location i; $E_{m(kjil)}$ is the residual. Analysis of variance and variance component estimation were performed for stalk height (cm), stalk diameter (mm), and stalk weight (kg) using the full model and for stalks per plant (no.) and plant weight (kg) using the full model with the $R(XBL)_{l(kji)}$ term excluded. Variance components were calculated by equating appropriate mean squares to their expectations and solving for the components.

We estimated the minimum number of families needed to provide a sufficient number of individuals for the next selection stage (first clonal stage) to maintain its present population size (3000 individuals). The estimate assumed selection without error of the best individuals and a family size of 200 individuals. Analysis confirmed the within family variance to be the same from family to family for the traits in this study. Assuming a normal distribution, the probability of a family giving elite individuals is a direct function of its mean. The standard normal deviate was calculated as:

PROB = Prob Z > (target - family mean) / family standard deviation.

Number of elite individuals per family = Prob(Z) (200 individuals per family).

Prob(Z) is the probability associated to a given standard normal deviate and is considered the percentage of individuals that would be expected on average to exceed the target value. Three target values were equilibrated to family means at the 75, 50, and 25th percentile value within a given crossing series.

RESULTS AND DISCUSSION

Cross mean squares were significant for all traits for 45 families planted at two locations while cross by location effects were nonsignificant (Table 1). Cross variance components were larger than cross by location components. Depending on the trait, variance components for residual errors ranged from 3 (stalks per plant) to 9.5 (stalk weight) times larger than cross components. Current LSVDP selection strategy does not perform multi-location testing until year five of the program. Individual plant selections are performed on first ratoon plants in early September, about 16 months after planting, to allow for natural selection for overwintering ability and to consistently produce stalks of sufficient planting size.

Correlations between the two locations are relatively low ($r = 0.14$ for stalk height to $r = 0.34$ for stalk diameter; Table 2). These low correlations are attributable to large residual errors, the other sources of variation and the low heritability of these traits. Family by environment interaction may be reduced by homeostasis, which likely contributed to family yield stability. Each family contains individuals that do well in different environments, but the average family response among locations was fairly similar. Additional studies from other crossing series and years should be evaluated to verify these findings.

Prior to screening individuals for sufficient sugar content (Brix), the LSVDP typically advances about 5500 individuals to the first clonal trial. Simulated selection was applied to 123 first ratoon families. Assuming selection without error, the minimum number of families needed to provide this amount of individuals increased with selection intensity (Table 3). Family means at three percentile rankings were used as hypothetical thresholds or target values. Depending on the trait and selection intensity, the minimum number of families varied from 27 (stalk weight) to 44 (stalks per plant) families of 200 individuals per family. Using the target value to be retained in the top 25% of the families, 55 families were needed to provide a sufficient number of individuals when selected for plant weight.

Empirical evidence from the field suggests family selection may help LSVDP personnel avoid selecting poor quality clones and perhaps improve the percentage of elite clones (Table 4). Initial family selection was first implemented on the 1991 crossing series whose selected individuals were advanced to the first clonal stage in 1993. There was a larger number of clones rated 4 or lower (more desirable) and fewer rated 7 or greater (less desirable) in 1994 as compared with earlier years. However, this observation is only for one year where family selection was practiced. The fidelity of this observation remains to be verified.

The frequency distribution of cane yield ratings indicates that the four raters found an average of 36% of the clones acceptable (Table 5). Eighty-five percent of the clones had no pith problem. Typically, two-thirds of the plants have sufficient Brix (sugar) to be advanced. This implies 16% of the plants originating from true seed should be advanced to the next selection stage [100(0.36)(0.85)(0.67) = 20.5%]. The LSVDP currently advances about 5% of the plants from the first selection stage. These results suggest that three quarters of the desirable clones are being missed. As indicated, however, selection personnel are not infallible. Adjusting for a three-quarters miss rate, the minimum number should be quadrupled (about 172 to 220 families depending on family size and selection intensity) to provide enough individuals for the first clonal stage based on plant weight. This is the approximate range that the LSVDP currently plants. Increased selection intensity of the better crosses would enable planting seedlings from fewer crosses.

Table 1. Stalk height, stalk diameter, stalk weight, stalks per plant and plant weight variance components and standard errors for first ratoon plants for 45 families from the 1992 crossing series.

Source	Stalk height	Stalk diameter	Stalk weight	Stalks per plant	Plant weight
	cm^2	mm^2	$kg^2 \times 10^{-2}$	$no.^2 \times 10^{-2}$	$kg^2 \times 10^{-2}$
Cross	90.39**	1.37**	0.86**	148.89**	98.11**
	±28.81	±0.60	±0.13	±60.70	±38.50
Cross x location	2.45	-0.64	-0.24	62.76	-19.84
	±21.03	±0.75	±0.09	±47.77	±26.04
Cross x block(location)	29.61	0.66	0.33	26.46	-12.63
	±27.66	±1.51	±0.14	±51.38	±40.14
Row(cross block location)	155.16**	1.64**	0.34*	-	-
	±27.83	±27.83	±0.15		
Residual	532.44	12.73	8.24	460.10	366.45
	±19.85	±19.85	±0.15	±58.51	±50.72

*, ** Significant mean square at the 0.05 and 0.01 probability levels, respectively.

Table 2. Correlations between locations for first ratoon plants for 45 families.

Ardoyne Farm	St. Gabriel Research Station				
	Stalk height	Stalk diameter	Stalk weight	Stalks per plant	Plant weight
Stalk height	0.14	0.10	0.16*	0.09	0.16*
Stalk diameter	-0.09	0.34**	0.26**	-0.05	0.11
Stalk weight	-0.01	0.38**	0.33**	-0.06	0.14
Stalks per plant	0.05	-0.19**	-0.15*	0.24**	0.11
Plant weight	0.03	0.07	0.08	0.17*	0.18*

*, ** Significant at the 0.05 and 0.01 probability levels, respectively.

Table 3. Number of families to get desired number of elite individuals.

Trait	Target Values†					
	75% Percentile Value		50% Percentile Value		25% Percentile Value	
	Number of Families	%	Number of Families	%	Number of Families	%
Stalk height	34	25	41	31	53	40
Stalk diameter	33	25	38	28	47	35
Stalk weight	27	20	29	22	32	24
Stalks per plant	44	33	49	37	58	43
Plant weight	43	32	46	34	55	41

† Prob = Prob(Z > (family mean - target) / family standard deviation.
No. of Elite Individuals per Family = Prob(Z)(200 individuals per family).

Table 4. First clonal plant cane ratings by year in the LSVDP.

Year‡	Clones	First line rating†							Total
		≤4	5	6	7	8	9	≥7	
1994	number	242	1493	887	65	2	1	68	2690
Family selection	%	(9.0)	(40.5)	(33.0)	(2.4)	(0.1)	(0.0)	(2.50)	
1993	number	76	710	654	781	713	580	2074	3514
No family selection	%	(2.2)	(20.2)	(18.6)	(22.2)	(20.3)	(16.5)	(59.0)	
1992	number	90	1531	901	202	26	-	228	2756
No family selection	%	(3.2)	(56.1)	(32.9)	(7.3)	(0.1)	-	(8.3)	
1991	number	30	437	1662	1417	896	141	2454	4583
No family selection	%	(0.7)	(9.5)	(36.3)	(30.9)	(19.6)	(3.1)	(53.5)	

† A lower rating is more desirable.
‡ Individuals with a rating <7 were retained in 1993 and 1991. Individuals with a rating <6 were retained in 1994 and 1992.

Table 5. Cane yield ratings for first ratoon clonal plots for four raters and number of acceptable clones.

	Cane Yield Rating†							
Rater	3‡	4	5	6	7	8	Mean	Total
1	16(3.2)	-	178(35.6)	-	306(61.2)	-	6.16	500
1 - w/o pith	14(3.3)	-	154(35.7)	-	263(61.0)	-	6.16	431
2	-	-	182(36.4)	-	318(63.6)	-	6.27	500
2- w/o pith	-	-	156(36.2)	-	275(63.8)	-	6.28	431
3	1(0.4)	15(6.0)	65(26.0)	107(42.8)	48(19.2)	14(5.6)	5.91	250
3 - w/o pith	-	10(4.7)	52(24.6)	93(44.1)	43(20.4)	12(5.7)	5.95	211
4	1(0.04)	17(6.8)	64(25.6)	104(41.6)	50(20.0)	14(5.6)	5.91	250
4 - w/o pith	-	11(5.2)	52(24.6)	91(43.1)	44(20.9)	12(5.7)	5.94	211
Total	18(1.2)	32(2.1)	489(32.6)	211(14.1)	722(48.1)	28(1.9)	6.11	1500
total - w/o pith	14(1.1)	21(1.6)	414(32.3)	184(14.4)	625(48.8)	24(1.9)	6.14	1282
At least one rater < 6	16(3.2)	14(2.8)	224(44.8)	52(10.4)	194(38.8)	-	5.79	500
w/o pith	14(3.3)	9(2.1)	194(45.0)	47(10.9)	167(38.8)	-	5.80	431
All raters < 6	-	-	111(22.2)	26(5.2)	349(69.8)	14(2.8)	6.53	500
w/o pith	-	-	95(22.0)	22(5.1)	302(70.1)	12(2.8)	6.54	431

† Rating < 6 indicate genotypes are acceptable.
‡ Number (percentage).

INTRAROW PLANT SPACING AND FAMILY BY ENVIRONMENT INTERACTION EFFECTS ON SUGARCANE CROSS EVALUATION

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Hybridization and the subsequent planting and selection among crosses and progeny is an important and demanding process in the Louisiana Sugarcane Variety Development Program. To facilitate hybridization, planting and initial selection decisions, a replicated cross appraisal test was initiated in 1991. The program evaluates first ratoon progeny from 130 to 250 crosses each August, about 16 months after transplanting.

Genotype by environment interaction negatively affects varietal selection decisions by confounding genotype effects and increasing non-genotype effects or error. Family by environment (FE) interaction is hypothesized to exist and negatively affect both family or cross evaluation and the ultimate development of stable cultivars. Work by Milligan and Legendre (1991) suggested the existence of FE interaction but did not measure its magnitude or effect on selection. More extensive work by Zaunbrecher (1995) suggests FE is not is not an important factor in cross evaluation, but his was only a single-planting study.

Results by Zaunbrecher (1995) clearly demonstrated the very large relative magnitude of the residual error in the cross appraisal process. Reevaluation of results by Chang and Milligan (1992ab) suggested that an intrarow plant spacing wider than currently used may improve the accuracy of the evaluation.

MATERIALS AND METHODS

Progeny of 25 randomly selected crosses from the 1993 L crossing series were transplanted to the field April 28, 1994 at the St. Gabriel Research Station near St. Gabriel, Louisiana, and to the USDA Ardoyne Farm near Chacahoula, Louisiana, on April 21, 1994. Progeny from each cross were planted in a randomized complete block design using two blocks with a split plot treatment arrangement where the main plots were intrarow plant spacings of 41 cm (normal) and 82 cm on rows 1.8 m apart. Subplots were crosses. Each subplot consisted of two rows up to 16 plants each. In November and December of 1994, stalk counts per plant were determined along with the stalk length and midstalk diameter of two stalks per plant. The stalk weight was estimated as the volume of the stalk assuming it was a cylinder with the density of one. Single plant cane yield (plant weight) was then estimated from the stalk weight and stalk number.

The full model analysis of variance assumed the completely random model:

$$Y_{ijklm} = \mu + S_i + L_j + SL_{ij} + B(SL)_{ijk} + C_l + LC_{jl} + SC_{il} + SLC_{ijl} + R(BCSL)_{ijklm} + P(RBCSL)_{ijklmn} + E_{ijklmno}$$

This project was partially funded by the American Sugar Cane League.

where observation Y was determined by the overall mean, μ, the intrarow plant spacing, S, the location, L, the block, B, the cross, C, the row, R, the plant, P, the designated interactions in the model, and the residual, E. Analysis were performed by and among plant spacings. Analysis by plant spacings used a reduced model where all effects except the $R(BCSL)_{ijklm}$ and $P(RBCSL)_{ijklmn}$ effects that included spacing were excluded from the analysis. The latter two effects were modified to not include the spacing effect. The given models were used to analyze stalk length, stalk diameter and stalk weight. Analysis for stalk number per plant and plant weight did not include the $P(RBCSL)_{ijklmn}$ term in the model. Pseudo F-tests (Hicks, 1973) were used to test cross mean squares in the multilocation x spacing analysis.

Variance components were obtained by equating mean squares to expectations. The components were used to estimate a cross CV (Cross CV = $100\sigma_C$/mean) and an estimated gain from family selection. The gain equation used:

$$\text{Gain} = i\,\sigma_C^2 / (\sigma_C^2 + \sigma_{CL}^2 / l + \sigma_{CS}^2 / s + \sigma_{CLS}^2 / ls + \sigma_{RBCLS}^2 / rbls + \sigma_{PRBCLS}^2 / prbls + \sigma_E^2 / prblsn)$$

where the selection intensity, i, assumed a 50% selection intensity from a family of 200, two blocks (b = 2), two rows (r = 2), one spacing (s = 1), and one location (l = 1). Sixteen plants per row (p = 16) were assumed for plant weight and stalk number, while five plants (p = 5) and two stalks per plant (n = 2) were assumed for stalk length, stalk diameter, and stalk weight. This selection scenario was used to simulate the current practice in the breeding program.

RESULTS AND DISCUSSION

The mean response within and among locations and spacings indicated that wider row spacings produced slightly taller stalks of minimally more narrow diameter yet slightly heavier stalks (Table 1). The mean and standard deviation of stalk number per plant and plant weight increased substantially with wider plant spacing yet the simple CVs decreased. Standard deviations and CVs of stalk weight, diameter and length were not meaningfully affected by plant spacing. The decrease in plant weight and stalk number CVs with the corresponding increases in means and standard deviations suggested these traits may be more accurately evaluated at wider plant spacings than currently used.

Significant cross mean squares were observed for all traits when analyzed by or among intrarow plant spacings (tables 2, 3 and 4). Cross x location effects were significant for stalk number, plant weight, and stalk length when analyzed both ways. Stalk weight only showed a significant cross x location interaction when the narrow spacing was used. Residual errors were universally very large in all analyses and traits. Cross by spacing mean squares were only significant for stalk weight and its components (Table 4). Cross CVs reflected gains increasing with wider spacings except for stalks per plant, which decreased with wider spacing.

Previous results (Chang and Milligan, 1992ab; Zaunbrecher, 1995) suggested that plant cane cross appraisal data predicted first ratoon results moderately well, although Zaunbrecher's (1995) results suggested its best used was in combination with first ratoon data. Plant cane data are not normally collected in the cross appraisal tests because the plants are generally too small

to measure. Frosts were late in 1995, enabling these measurements. This study is to be repeated and first ratoon data will be collected. Correspondence with the presented results will be of interest.

ACKNOWLEDGMENTS

This work could not be performed without help from Keith Bischoff, Harry Schexnayder, Patrick Rodriguez, Kenny Quebedeaux, and Lawrence Frazier in germination and potting of the seedlings. This crew and USDA personnel under the direction of Dave Verdun transplanted the seedlings on the appropriate farms. Data collection was with the help of student and transient labor at both farms with the additional help by Mr. Verdun at the USDA location.

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Table 1. Means, standard deviations and coefficients of variation of 25 plant cane sugarcane families grown at two locations and two intrarow plant spacings in 1994.

Location	Intrarow plant spacing	Trait†				
		Plant weight	Stalk number	Stalk weight	Stalk diameter	Stalk length
		kg	no. plant^{-1}	kg	mm	cm
Ardoyne Farm	narrow	5.21±3.77 (72)	6.58±3.47 (53)	0.76±0.35 (46)	21.0±3.8 (18)	208±46 (22)
Ardoyne Farm	wide	6.81±4.22 (62)	8.96±4.27 (48)	0.75±0.35 (47)	21.2±3.8 (18)	199±45 (22)
Ardoyne Farm	mean	6.02±4.08 (68)	7.79±4.07 (52)	0.76±0.35 (47)	21.1±3.8 (18)	204±45 (22)
St. Gabriel Res. Stn.	narrow	4.86±3.34 (69)	7.38±4.02 (54)	0.64±0.30 (47)	21.0±0.3 (18)	174±39 (23)
St. Gabriel Res. Stn.	wide	8.02±4.82 (60)	11.03±5.17 (47)	0.73±0.34 (46)	22.7±4.1 (18)	171±37 (22)
St. Gabriel Res. Stn.	mean	6.49±4.46 (69)	9.26±5.00 (54)	0.68±032 (47)	21.9±4.1 (19)	173±38 (22)
mean	narrow	5.03±3.56 (71)	6.97±3.77 (54)	0.70±0.34 (47)	21.0±3.8 (18)	191±46 (24)
mean	wide	7.41±4.57 (62)	9.99±4.85 (49)	0.74±0.34 (47)	21.9±4.0 (18)	185±44 (24)
mean	mean	6.25±4.28 (68)	8.52±4.61 (54)	0.72±0.34 (47)	21.5±3.9 (18)	188±45 (24)

† Mean ± standard deviation (coefficient of variation).

Table 2. Variance components, means, genetic coefficients of variation, gain from family selection for stalks per plant and plant weight at two intrarow plant spacings.

Source	Stalks per plant		Plant weight	
	Narrow	Wide	Narrow	Wide
	(no. plant^{-1})^2		kg^2	
Cross	0.424** ±0.226	0.702* ±0.522	0.677** ±0.257	2.080** ±0.798
Cross* location	0.242** ±0.158	0.887** ±0.463	0.088§ ±0.114	0.589** ±0.396
Row(cross loc rep)	-0.116 ±0.105	0.143§ ±0.214	-0.146 ±0.093	0.320** ±0.213
Error	13.602 ±0.473	21.526 ±0.720	12.032 ±0.439	18.593 ±0.655
	no. plant^{-1}		kg^2	
Mean	6.97 ±3.77	9.99 ±4.85	5.03 ±3.56	7.41 ±4.57
	%			
Cross CV	9.3	8.4	16.4	19.5
Family gain with 50% selection intensity†	5.0	3.9	10.8	12.6

§, *, ** Mean square was significant at the P= 0.10, 0.05 and 0.01 level, respectively.
† Gain from selection assumed one location, two reps, two rows and 16 plants per row.

Table 3. Variance components, means, genetic coefficients of variation, gain from family selection for stalk length, stalk diameter and stalk weight at two intrarow plant spacings.

Source	Stalks length		Stalk diameter		Stalk weight	
	Narrow	Wide	Narrow	Wide	Narrow	Wide
	-------- cm^2 ---------		------- mm^2 -------		--- $(kg \times 10^{-2})^2$ ----	
Cross	138.6** ±46.3	184.8** ±61.2	1.388** ±1.940	1.906** ±3.120	0.98** ±27.02	1.57** ±41.90
Cross*location	22.1* ±14.9	32.9* ±18.7	-0.022 ±0.416	-0.060 ±0.411	0.11* ±8.65	0.08 ±10.34
Row(cross loc rep)	51.1** ±14.1	63.2** ±15.5	0.140* ±0.163	0.269** ±0.453	0.13* ±6.00	0.28** ±8.66
Plant(row cross rep loc)	729.9** ±2.1	828.3** ±1.9	7.386** ±0.072	8.156** ±0.068	5.09** ±1.10	5.99** ±1.12
Error	771.8 ±21.1	557.5 ±14.7	5.268 ±0.470	5.131 ±0.294	4.01 ±10.32	3.74 ±7.48
	-------- cm --------		-------- mm -------		--------- kg --------	
Mean	191 ±46	185 ±44	21.0 ±3.8	21.9 ±4.0	0.70 ±0.34	0.74 ±0.34
	---------- % ----------					
Cross CV	6.2	7.3	5.6	6.3	14.1	16.9
Family gain with 50% SI†	3.8	4.7	3.8	4.4	9.1	11.6

*, ** Mean square was significant at the P= 0.05 and 0.01 level, respectively.
† SI = selection intensity. Gain from selection assumed one location, two reps, two rows, five plants per row, and two stalks per plant.

Table 4. Variance components, means, genetic coefficients of variation, gain from family selection for plant weight, stalk number per plant, stalk length, stalk diameter and stalk weight among two intrarow plant spacings and two locations.

Source	Plant weight	Stalk number	Stalk weight	Stalk length	Stalk diameter
	kg^2	$(no.\ plant^{-1})^2$	$kg^2 \times 10^{-2}$	cm^2	mm^2
Cross	0.940** ±0.361	0.573** ±0.263	1.17** ±31.38	146.5** ±48.6	1.505** ±2.321
Cross x location	0.222* ±0.146	0.289** ±0.177	0.07 ±6.84	16.4§ ±12.0	0.039 ±0.296
Cross x spacing	0.094 ±0.084	-0.150 ±0.067	0.10* ±7.05	15.2§ ±11.8	0.142** ±0.456
Cross x loc x spacing	0.031 ±0.106	0.104 ±0.134	0.02 ±6.85	9.8 ±12.2	-0.082 ±0.305
Row(block cross spacing location)	0.121§ ±1.696	0.163§ ±1.851	0.22** ±5.47	62.4** ±10.9	0.211** ±0.235
Plant (row block cross spacing loc)	-	-	5.55** ±12.59	780.8** ±22.5	7.782** ±0.788
Residual	14.883 ±0.005	17.071 ±0.006	3.87 ±0.08	660.9 ±0.2	5.197 ±0.004
	kg	no. plant $^{-1}$	kg x 10^{-2}	cm	mm
Mean	6.25 ±4.28	8.52 ±4.61	0.72 ±0.34	188 ±45	21.5 ±3.9
	---------- % ----------				
Cross CV	15.5	8.9	15.0	6.4	5.7
Family gain with 50% SI†	9.4	4.9	9.7	3.8	3.8

§, *, ** Mean square was significant at the P= 0.10, 0.05 and 0.01 level, respectively.
† SI = selection intensity. Gain from selection assumed one spacing, one location, two reps, and 16 plants per row for plant weight and stalk number, and five plants per row for stalk weight, length and diameter.

GERMINATION MEDIA EFFECTS ON SEED TESTING

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Sugarcane seed is attached to wind dispersal appendages known as pappus. The pappus and seed is collectively called fuzz. The LAES Sugarcane Variety Development Program's sugarcane seed produced from hybridizations are grown in metal flats for about one month prior to transplanting the seedlings into Speedling© trays. The seedlings are then grown in the trays for six to eight weeks prior to mechanical transplanting into the field (Bischoff et al., 1989). Methodology has evolved where an estimated 750 seedlings are planted in each flat. This estimate is based on a emergence test of a ½ gram of fuzz.

Two soil mixes are used to produce sugarcane seedlings. A Commerce silt loam, sand, and milled sphagnum moss soil mix (8:2:3 v:v) is used for the initial germination of seed in the metal flats prior to transplanting into Speedling© trays. Seedlings produced in the Speedling© trays are grown in a presterilized commercial peat-vermiculite mix (Jiffy Mix©). Seed viability tests have traditionally been performed in mid-December using the field-soil mix. The field soil/sand mix is screened and heat sterilized (>93° C for at least 2 h) prior to mixing with the moss. For convenience, germination tests are delayed until enough seed from crosses are available to use all or most of the soil mix needed to fill the sterilizing box. This delays testing until the end of the season. This late information further inconveniences year-end analysis and typically uses about six to eight people to perform the tests, since they are all done at once. If the tests could be more evenly distributed during the fall as the crosses ripened, the work could be more conveniently performed by just one or two people.

We questioned if the Jiffy Mix© would effect different seed viability results than the field-soil mix. If not, it could be used to perform these tests in a more desirable time frame since it did not have to sterilized.

MATERIALS AND METHODS

Six randomly chosen crosses from the 1994 crossing series were replicated in a split-plot treatment arrangement. Metal flats (52 x 36 x 10 cm) were filled with about (3/4 volume) of field-soil mix or Jiffy Mix©. Each flat was divided into six partitions with each partition being planted with ½ gram of fuzz from each cross. The fuzz was misted with water and then barely covered with the appropriate soil mix. The new soil was watered and flats were covered with a transparent plexiglass sheet until seedling emergence (about two to three days). After one week of growth, the number of seedlings were counted. This procedure with the use of the field soil mix is the current practice to generate seed viability data.

Analysis of variance of seedling number assumed a randomized complete block design in a split-plot treatment arrangement. Soil type was considered the fixed main effect with crosses considered as the random subplot effect. Two replications were used.

RESULTS AND DISCUSSION

Soil mix had no effect on emergence nor was there any soil mix by cross interaction (tables 1 and 2). Cross effects were the only significant effect in the model. The correlation among the two mixes was nearly perfect (r = 0.98).

Jiffy Mix® can clearly be substituted for the field soil mix with no difference in germination counts. Use of Jiffy Mix® would facilitate more convenient processing of the newly made seed and lessen the work load at season end.

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Table 1. Analysis of variance for soil mix effect of sugarcane fuzz germination.

Source	df	Mean squares
		plants^2
Replication	1	8.17
Soil	1	0.67
Replication x soil	1	1.50
Cross	5	14833.70****
Cross x soil	5	61.37
Residual	10	60.63

**** $p < 0.0001$

Table 2. Mean germination among and within soil mixes for six sugarcane crosses.

Cross	Jiffy Mix®	Field-soil mix	Mean
	---------- plants ----------		
XL94-009	187.0	187.0	187.0
XL94-102	163.0	153.5	158.3
XL94-060	96.0	88.0	92.0
XL94-018	77.0	89.0	83.0
XL94-067	76.5	77.0	76.8
XL94-052	16.5	19.5	18.0
$LSD_{0.05}$	---------- 17.4 ----------		12.3
Mean	102.7	102.3	102.5

THE 1994 LOUISIANA SUGARCANE VARIETY SURVEY

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Each year the Louisiana Cooperative Extension Service conducts variety surveys to determine the varietal makeup and distribution across the sugarcane acreage. The 1994 survey was conducted in June and July, near the middle of the growing season. Extension agents in each sugarcane producing parish collected acreage figures by variety and crop year from growers in their parishes. Some information was also collected from the local ASCS[1] office when the agents had difficulty in obtaining all the needed information from the growers. Since this information was collected during the growing season and included input from many persons, it may differ slightly from the final total crop acreage figures collected at harvest.

Acreages for each parish, regional totals, and the statewide total are shown in Table 1. The statewide total of 382,408 acres is down about 6,000 acres from the survey total for 1993. Regional totals were 167,005 acres for the Teche region, 106,813 for the River-Bayou Lafourche region and 54,590 acres for the Northern region in 1994. These totals indicate drops in acreage in the Teche and River-Bayou Lafourche regions and an increase in the acreage in the Northern region compared to 1993.

Statewide acreages of each variety for each crop year and the total for each variety are shown in Table 2. The two leading varieties CP 70-321 and CP 65-357 made up 47.4 and 21.6 per cent, respectively, of the total acreage. CP 72-370 and LCP 82-89 made up 9.5 and 8.4 per cent, respectively, of the total acreage. No other variety contributed more than 5 per cent of the acreage.

Acreage distribution by region and crop year are shown in Table 3. The total acreage for each region and for the entire state was made up of almost equal percentages of plant cane, first stubble, second stubble, and older (the three categories used to classify crop year). Readjustments of the cropping cycle following the disruptive effect of the 1989-90 freeze appear to be almost completed.

Varietal makeup by crop year is shown for the Teche, River-Bayou Lafourche, and Northern regions in tables 4,5,and 6 respectively. Approximately two thirds (66.9%) of the acreage in the Teche region was planted to CP 70-321. Other varieties that contributed 5 per cent or more of the total acreage in this region were CP 65-357 (10.5%), LCP 82-89 (7.3%), and CP 72-370 (5.5%). In the River-Bayou Lafourche region, CP 65-357 was the most prevalent variety with 33.9 per cent of the total acreage. CP 70-321 was second in acreage occupying 27.9 per cent of the total acreage. Other varieties that occupied 5 per cent or more of the total acreage in this region included CP 72-370 (11.4%), LCP 82-89 (10.9%), and CP

[1] ASCS was changed to Consolidated Farm Service Agency in November 1994.

74-383 (6.7%). In the Northern region, the leading variety was CP 70-321 with 45.6 per cent of the total acreage. Other varieties that contributed 5 per cent or more of the total acreage included CP 65-357 (19.2%) and CP 72-370 (16.1%).

Sugarcane variety trends over the last five years are shown in Table 7. One of the most obvious trends is the declining contribution of CP 65-357 over this time period. It has dropped from 35% of the total acreage in 1990 to 25% in 1993 to 22% of the acreage in 1994. During that five year time period, CP 70-321 increased from 39% to 47% of the total acreage. Some of the varieties included in the survey have become available to growers for the first time during this time period and are being grown on small but increasing percentages of the acreage. Acreage devoted to LCP 82-89 has increased from 0 in 1990 to 8.4% of the total in 1994. Others have shown smaller increases, perhaps because they have been available for shorter time periods.

Table 1. Estimated Total Sugarcane Acres by Parish and Region, 1994[1].

Teche Region		River-Bayou Lafourche Region		Northern Region	
Parish	Acres	Parish	Acres	Parish	Acres
Acadia	540.3	Ascension	16,299.0	Avoyelles	13,394.0
Calcasieu	103.8	Assumption	36,315.1	East Baton Rouge	648.6
Iberia	57,190.0	Iberville	34,244.0	Evangeline	163.7
Lafayette	10,981.1	Lafourche	31,636.0	Pointe Coupee	17,475.0
St. Martin	31,485.1	St. Charles	2,225.0	Rapides	4,113.8
St. Mary	46,154.5	St. James	23,519.4	St. Landry	6,310.0
Vermilion	20,550.3	St. John	5,743.3	West Baton Rouge	12,485.0
		Terrebonne	10,831.0		
TOTAL	167,005.1	TOTAL	160,812.8	TOTAL	54,590.1
All Crops: 382,408.0 Acres					

[1] Based on 1994 variety survey information from county agents

Table 2. Estimated Sugarcane Acreage by Variety and Crop Year, 1994[1].

Variety	Plant Cane (%)	1st Stubble (%)	2nd Stubble & Older (%)	Total (%)
CP 65-357	19.4	20.1	25.1	21.6
CP 70-321	47.3	44.5	50.2	47.4
CP 72-370	8.4	11.1	9.2	9.5
CP 74-383	3.6	4.8	5.4	4.6
CP 76-331	1.0	1.7	1.0	1.2
CP 79-318	3.0	2.9	2.6	2.8
LCP 82-89	10.3	11.0	4.1	8.4
LHo 83-153	4.4	2.5	0.8	2.6
LCP 85-384	1.4	0.5	0.2	0.7
Others	1.2	0.9	1.5	1.2
Total	100.0	100.0	100.1	100.0

[1] Based on 1994 variety survey information from county agents.

Table 3. Estimated Sugarcane Distribution by Region and Crop Year, 1994[1].

Crop Year	Teche Region	River-Bayou Lafourche Region	Northern Region	State Total
Plant Cane				
Acres	61,782	54,404	16,385	132,571
%	37.0	33.8	30.0	34.7
1st Stubble				
Acres	49,099	50,104	19,752	118,955
%	29.4	31.2	36.2	31.1
2nd Stubble and Older				
Acres	56,124	56,304	18,453	130,882
%	33.6	35.0	33.8	34.2
Total				
Acres	167,005	160,813	54,590	382,408
%	100.0	100.0	100.0	100.0

[1] Based on 1994 variety survey information from county agents.

Table 4. Estimated Teche Region Sugarcane Acreage by Variety and Crop Year, 1994[1].

Variety	Plant Cane (%)	1st Stubble (%)	2nd Stubble & Older (%)	Total (%)
CP 65-357	8.1	9.6	13.8	10.5
CP 70-321	68.1	63.1	69.0	66.9
CP 72-370	5.3	6.5	5.0	5.5
CP 74-383	2.1	2.7	3.3	2.7
CP 76-331	0.1	0.1	0.6	0.3
CP 79-318	2.6	2.5	1.7	2.3
LCP 82-89	8.0	11.3	3.2	7.3
LHo 83-153	3.0	2.7	0.6	2.1
LCP 85-384	1.2	0.2	0.0	0.5
Others	1.7	1.5	2.8	2.0
Total	100.2	100.2	100.0	100.1

[1] Based on variety survey information from county agents.

Table 5. Estimated River-Bayou Lafourche Region Sugarcane Acreage by Variety and Crop Year, 1994[1].

Variety	Plant Cane (%)	1st Stubble (%)	2nd Stubble & Older (%)	Total (%)
CP 65-357	33.4	33.3	34.9	33.9
CP 70-321	24.1	25.9	33.2	27.9
CP 72-370	10.8	12.1	11.3	11.4
CP 74-383	4.9	6.9	8.2	6.7
CP 76-331	0.5	1.3	1.3	1.1
CP 79-318	3.2	3.5	3.5	3.4
LCP 82-89	14.2	13.1	5.9	10.9
LHo 83-153	6.9	3.1	1.1	3.7
LCP 85-384	1.5	0.3	0.1	0.6
Others	0.7	0.4	0.5	0.5
Total	100.2	99.9	100.0	100.1

[1] Based on 1994 variety survey information from county agents.

Table 6. Estimated Northern Region Sugarcane Acreage by Variety and Crop Year, 1994[1].

Variety	Plant Cane (%)	1st Stubble (%)	2nd Stubble & Older (%)	Total (%)
CP 65-357	15.4	12.9	29.2	19.2
CP 70-321	46.5	45.3	45.1	45.6
CP 72-370	12.1	20.0	15.6	16.1
CP 74-383	5.0	4.7	3.4	4.3
CP 76-331	6.5	6.4	1.2	4.7
CP 79-318	4.1	2.4	2.4	2.9
LCP 82-89	6.4	4.9	1.2	4.1
LHo 83-153	1.2	0.6	0.3	0.7
LCP 85-384	1.8	2.1	1.1	1.7
Others	1.0	0.6	0.7	0.7
Total	100.0	99.9	100.2	100.0

[1] Based on 1994 variety survey information from county agents.

Table 7. Louisiana Sugarcane Variety Trends 1990-1994[1].

	% of State Total Acreage by Year					
Variety	1990	1991	1992	1993	1994	1 yr. change
CP 65-357	35	29	29	25	22	-3
CP 70-321	39	47	48	45	47	+2
CP 72-356	2	0.8	--	--	--	--
CP 72-370	10	10	9	11	9.5	-1.5
CP 74-383	6	6	5	5.3	4.6	-0.7
CP 76-331	3	2.1	1.6	1.6	1.2	-0.4
CP 79-318	4	4.4	4.0	3.5	2.8	-0.7
LCP 82-89	--	0.5	1.9	5.9	8.4	+2.5
LHo 83-153	--	--	0.3	1.4	2.6	+1.2
LCP 85-384	--	--	--	--	0.7	+0.7
Others	1	0.9	1.0	0.7	1.2	+0.5
TOTAL	100	100	100	100	100	--

[1] Based on variety survey reports from county agents in sugarcane producing parishes 1990-94

ASSESSMENT OF VARIETAL RESISTANCE TO THE SUGARCANE BORER

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Resistance to Diatraea saccharalis (F) damage (SCB) in sugarcane can be categorized predominately as antibiosis. Physical characteristics of the plant, such as leaf-sheath appression and rapid rind hardness development, contribute to the differential survival of young larvae among cultivars. Also, additional mortality factors in certain cultivars seem to affect survival and development of larger larvae in the stalk. The use of percent bored internodes is means of ranking sugarcane cultivars on observed external evidence of D. saccharalis tunneling into the stalk. However, the degree of internal damage to the plant and the ultimate survival of D. saccharalis larvae are not addressed with this assessment. Varietal resistance to the latter stages of D. saccharalis injury is a primary goal of the entomology contribution to the LAES breeding program.

The L-92 series (33 cultivars) and four commercial cultivars used as standards (CP 70-321, CP 65-357, CP 74-383, and LCP 85-384) were planted on September 23,1993, in a four-replicate randomized block design on the Lanaux Plantation, Killona, LA. Two plots of each commercial cultivar and one plot of each L92 cultivar were planted in each replication. On November 18, 1994, a 15-stalk sample was cut from each replicate (4 replications = 60 stalks per 92 cultivar and 2 plot x 4 reps =120 stalk per commercial cultivar). Each sugarcane stalk was examined to determine the number of bored internodes, moth emergence, and the total number of internodes. In this test, no insecticides were used for control of the SCB; however, granular Lorsban was applied in late July to suppress the fire ants and enhance SCB infestation.

The overall sugarcane borer infestation was comparable to the 1993 test (1991 cultivars). The highest recorded SCB infestation in the experimental variety was 28.6% bored internodes in LHo 92-307 with the highest moth emergence in the experiment of 25,000 per acre. Only one cultivar, LHo 92-314, was close to the economic threshold of 10% bored internodes with only 6,300 moth emergence per acre. Due to a change in the varietal program, 24 L92 cultivars were dropped from the breeding program prior to entomological data collection in this series.

Table 2 lists the first stubble test of the L-91 series planted on October 2, 1992, in a four- replicate randomized block design on Lanaux Plantation. Data on percent bored internodes and moth emergence were collect on two L-91 series and four commercially cultivated varieties. The two experimental cultivars, 91-250 and 91-281, had the highest SCB injury with 19.8% and 21.9% bored internodes, respectively. L 91-250 had the highest number of moth emergences (9,000 per acre), while 91-281 was below average for this experiment.

Relative to this insect pest in sugarcane, a grower's primary objective is to minimize economic impact. There are two approaches to reduce the economic impact of pests. The first is to minimize the overall cost incurred in controlling the pest. Use of resistant varieties reduces pest damage at little or no cost to the grower. Resistance rating schemes traditionally have

focused on the prevention of damage, whereas our research now provides an additional criterion. Incorporating the cultivar's pest survival rating allows us to flag varieties that enhance D. saccharalis populations, involves little additional data collection, and enhances the efficiency and value of the entomological component in sugarcane breeding and varietal development of the LSU Agricultural Center.

Table 1. *Diatraea saccharalis* plant cane damage and survival inside the stalk of four commerical and nine experimental cultivars from the 1992 L series during 1994 on the Lanaux Plantation, Killona, LA.

Variety	Internodes per stalk	% Bored internodes	% Internodes exited	% Survival	Moths emergence (No./Acre)
CP 70-321	17.7	15.4	3.6	24.5	16,400
CP 65-357	15.2	26.1	4.6	18.1	16,300
LCP 85-384	16.1	29.2	5.5	19.9	30,400
CP 74-383	14.5	39.2	8.4	21.8	36,600
LHo 92-314	17.7	10.6	1.4	11.7	6,300
L 92-315	17.8	22.4	4.6	23.0	22,000
L 92-321	18.9	22.5	3.8	17.1	14,500
L 92-319	20.1	23.0	3.2	14.1	16,800
L 92-355	17.3	23.6	4.0	17.5	21,000
L 92-310	20.1	25.5	4.8	18.7	23,000
L 92-313	16.0	27.0	2.8	10.5	15,200
LHo 92-307	16.9	28.6	6.5	24.9	25,000
MEAN	16.9	25.0	4.6	18.8	21,000
$LSD_{0.05}$	2.3	9.5	2.6	10.4	12,800

% Survival = the percent of bored internodes that an adult emergenced.
Moth Emergence = number of internodes exited times each cultivars population from the 1994 nursery.

Table 2. *Diatraea saccharalis* first ratoon damage and survival inside the stalk of four commercial and two experimental cultivars from the 1991 L series during 1994 on the Lanaux Plantation, Killona, LA.

Variety	Internodes per stalk	% Bored internodes	% Internodes exited	% Survival	Moth emergence (No./acre)
CP 70-321	14.8	5.7	0.7	13.3	2,800
CP 74-383	14.5	11.3	1.9	22.3	8,300
CP 79-318	15.7	15.4	1.2	8.5	4,300
CP 65-357	14.5	17.5	2.3	10.0	8,500
L 91-250	13.9	19.8	2.2	12.1	9,000
L 91-281	13.7	21.9	1.5	5.5	5,800
MEAN	14.5	15.3	1.6	11.9	6,400
$LSD_{0.05}$	2.4	12.4	2.3	14.3	8,600

% Survival = the percent of bored internodes that an adult emergenced.
Moth Emergence = number of internodes exited times each cultivars population from the 1994 nursery.

INSECTICIDAL AND VIRAL CONTROL OF THE SUGARCANE BORER SMALL-PLOT TEST

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Control of the SCB was evaluated in a randomized complete block design (4 replications) of plant cane variety LCP 85-384 at the St. Gabriel Research Station, St. Gabriel, LA. Insecticide treatments were applied over the sugarcane canopy with a CO_2 backpack sprayer on 22 July, 8 August, and 26 August when the SCB infestation exceeded the economic threshold (5% of the stalks containing live larvae in the leafsheaths). Four 0.004 flat fan spray tips per 6 ft width of row at 32 psi applied 20.1 gal of finished formulation per acre. Prior to the initiation of the experiment, 2 applications of Lorsban 15G were made (15 lb/acre each) to suppress red imported fire ant predation on SCB larvae (10 May and 9 June). Due to weather conditions the timing of the first application was delayed 12 days. The three Rohm & Haas treatments (RH-2485, RH-0345 and Confirm) were applied with Triton CS-7 at 0.125% v/v, and the Condor treatment was applied with Kinetic at a rate of 0.125% v/v. SCB damage was assessed by counting the bored internodes, exit holes, and total number of internodes from 80 randomly selected stalks of sugarcane (20 stalks/ replication) in each treatment (18 October). Following ANOVA, separation of means was by LSD.

Due to inadequate timing of the first application, initial injury of 16% bored internodes was sustained prior to initiation of the experiment. Consistently heavy infestation pressure resulted in 50.6% bored internodes in the untreated check and adult emergence of 1.25 moths per stalk (Table 1). Only 2 of the treatments (Fury and FCR 4545) provided fewer than 10% bored internodes (economic injury level). RH-0345 and Condor had greater than 30% bored internodes, and all insecticide treatments except RH-0345 provided significantly fewer bored internodes than the untreated control.

In a separate experiment, season-long control of the SCB was evaluated using a pathogenic virus (CGI 9409) in a randomized complete block (4 reps.) of plant cane LCP 85-384 at the St. Gabriel Research Station. Two biological treatments were compared with an insecticide treatment and an untreated control. All treatments were applied in the same manner described above on the dates of 20 July, 10 August, and 1 September. The two CGI treatments were applied with Plyac at 6 oz./100 gallons and powdered skim milk at .5% w:v. Fireants were also suppressed in the manner described in the test above.

Neither rate of the CGI-9409 treatments was significantly different from the untreated in bored internodes and moth emergence. The Asana XL treatment provided significant control of SCB compared with all other treatments (Table 2).

Project cooperated with Dr. William H. White, USDA (ARS).

Table 1. Results from Small Plot Insecticide Trails to Control the Sugarcane Borer at the St. Gabriel Research Station, 1994.

Treatment/Form.	Rate lb(AI)/ac	% Bored Internodes	Moth emergence (No./stalk)
Fury 1.5 EC	0.04	7.5a	0.16ab
FCR 4545 1EC	0.0165	10.0ab	0.13a
Baythroid 2E	0.033	10.3ab	0.26abcd
Karate 1EC	0.02	11.7abc	0.20abc
Confirm 2F	0.125	12.9abc	0.23abcd
Asana 0.66 EC	0.033	13.9abc	0.48abcd
Confirm 2F	0.125	14.3abc	0.34abcd
Confirm 2F	0.625	14.5abc	0.34abcd
Karate 1EC	0.03	14.6abc	0.53abcde
Guthion 2L	0.75	16.8abc	0.43abcd
Baythroid 2L	0.016		
+ Guthion 2L	0.45	17.5abc	0.50abcd
RH-2485 2F	0.032	18.6abc	0.48abcd
Ammo 2.5EC	0.07	18.6abc	0.36abcd
Asana 0.66EC	0.021		
+ Orthene 75S	0.14	20.3abc	0.39abcd
Asana 0.66EC	0.021		
+ Guthion 2L	0.45	21.2bc	0.65cde
Orthene 75S	1.0	23.2c	0.59bcde
Condor	1.66qt.[a]	36.7d	0.66de
RH-0345 2F	0.032	39.4de	0.96ef
Control	---	50.6e	1.25f
P>F(ANOVA)		0.0001	0.0008
LSD(0.05)		12.8	0.45

Means followed by same letter do not differ significantly (P=0.05,LSD).

[a] Actual amount of insecticide applied.

Table 2. Results from Small Plot Viral Trails to Control the Sugarcane Borer at the St. Gabriel Research Station, 1994.

Treatment/Form	Rate (AI)/ac	% Bored Internodes	Moth Emergence (No./Stalk)
Asana 0.66 EC	0.033 lbs.	16.8a	0.31a
Untreated check	---	47.0b	0.79b
CGI-9409	50 g	51.6b	0.95b
CGI-9409	20 g	52.3b	0.93b
P>F(ANOVA)	---	0.001	0.03
LSD(0.05)	---	16.7	0.45

Means followed by same letter do not differ significantly (P=0.05, LSD).

EFFECTS OF INSECTICIDES USED TO CONTROL THE SUGARCANE BORER ON NON-TARGET INSECTS

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Six different insecticide treatments were used for control of SCB at Goldmine Farm, near Edgard, LA. Treatments were randomly assigned to plots (about 2.12-1.03 acres) according to randomized complete block design with 4 replications. Plots were treated when 5% of sugarcane stalks contained live larvae of third instar or smaller in leaf sheaths (28 June, 26 July, and 20 August). Treatments were applied in water using a Cessna AG Cat with swaths of 54 ft. (9 rows) delivering 2 gallons per acre of finished formulation. Confirm treatments were applied with CS-7 at a rate of 0.025% V/V. Non-target insects were monitored continuously using 3 pitfall traps (pint jars filled with 150 ml 70% ethanol and 40 ml mineral oil) embedded to the soil surface near the center of each plot and spaced 20 yards apart. Traps were sheltered by a 22-cm diameter disc supported on a tripod at 4 cm above the surface. Traps were first installed 7 July, collected and replaced 26 July and 16 August, and removed on 12 September.

Differences were not detected among treatments in the number of fire ants, field crickets, rove beetles, and tiger beetles collected. However, there was a trend for higher numbers of fire ants in Asana treated plots, which had the highest infestations of the yellow sugarcane aphid (reported in another test). There were no clear differences in the number of ground beetles among treatments (including the untreated plots). Untreated plots and Confirm plots did not differ from each other and had about 2.3 times more wolf spiders than in the other treatments. Asana/Orthene plots had higher numbers of earwigs than the other insecticide treatments and the untreated plots. Both Karate treatments had 98% fewer pigmy mole crickets than the untreated plots.

Project cooperated with Dr. William H. White, USDA (ARS).

Table 1. Average number of insects per trap per sample period at Goldmine Farm.

Treatment/form	Rate lb (AI)/ac	Fire ants	Wolf spiders	Field crickets	Earwigs	Pigmy mole crickets	Ground beetles	Rove beetles	Tiger beetles
Asana XL 0.66E	0.033	140.91	1.37b	31.26	1.86cb	2.49cd	0.46c	2.20a	6.06
Confirm 2E	0.125	59.27	3.09a	28.64	0.88c	3.76cb	1.45bc	2.36a	8.82
Baythroid 2E Guthion 2L	0.016 + 0.37	54.53	1.66b	32.21	3.09cb	1.53cd	1.94ab	2.06ab	7.41
Karate 1EC	0.025	32.91	1.56b	35.92	2.74cb	0.21d	1.50abc	1.53ab	2.98
Karate 1EC	0.03	47.06	0.86b	40.17	3.42b	0.11d	2.34ab	1.17b	3.66
Orthene 75S Asana XL 0.66E	0.18 + 0.02	48.58	1.55b	41.07	7.07a	5.16b	1.48abc	1.68ab	7.52
Untreated		58.91	3.32a	32.44	2.09cb	8.85a	2.91a	2.15a	9.09
P>F(ANOVA)			0.0001		0.0003	0.0001	0.033		
LSD(0.05)			0.97		2.47	2.47	1.4		

AERIAL APPLICATION FOR CONTROL OF THE SUGARCANE BORER AND YELLOW SUGARCANE APHID

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Deparment of Entomology

Six insecticide treatments were tested for season-long control of SCB at Goldmine Farm, located in Edgard, LA. A RCB design (4 reps) that incorporated 28 plots of CP 74-383 ratoon sugarcane was utilized. Plot size ranged from 2.12 to 1.03 acres. Each treatment was applied in water using a Cessna Ag Cat with swaths of 54 ft. (9 rows) delivering 2 GPA finished formulation (the Confirm treatment was applied with Laxtron CS-7 at a rate of .125% v/v). Infestations were monitored weekly, and plots were treated first on 25 June, when 5% of sugarcane stalks contained live (SCB) larvae (3rd instars or smaller) in the leaf sheaths. All plots were retreated when the Asana XL treatment contained an infestation of 5% live larvae in the leaf sheaths (26 July and 20 August). Percent mortality was assessed 3 days after treatment by collecting and identifying stage of 15-20 larvae per plot. To determine the length of control and if additional applications were needed, weekly SCB infestation counts were made in each plot. SCB damage was assessed by counting the number of bored internodes, exit holes, and the total number of internodes of 75 sugarcane stalks per plot (5 sites/plot, 15 stalks/site) on 17 October (Table 1). YSA infestations were monitored weekly by counting the number of YSA on the 3rd or 4th leaf below the whorl of 20 randomly selected plants (Table 2). Plot weights were assessed by weighing 600 ft of row cane per treatment with a hydraulic scale mounted on a tractor (28, 29 October and 7,9 November). Analysis of Variance were conducted and separation of means was by LSD.

All insecticide treatments provided significant SCB control when compared with the untreated check. Initial kill in pyrethroid (Asana XL and Karate) treated plots was significantly reduced due to an absence of rainfall and low moisture within the first 3 days following the first application. Aphids numbers built up in the Asana XL alone treatment but were substantially suppressed in Karate treatments. Adding Guthion or Orthene to a pyrethroid (Baythriod or Asana XL) reduced the potential for aphid infestation build up.

Project cooperated with Dr. William H. White, USDA (ARS).

Table 1. Aerial Application Test 1994, Goldmine Plantation, Edgard, LA.

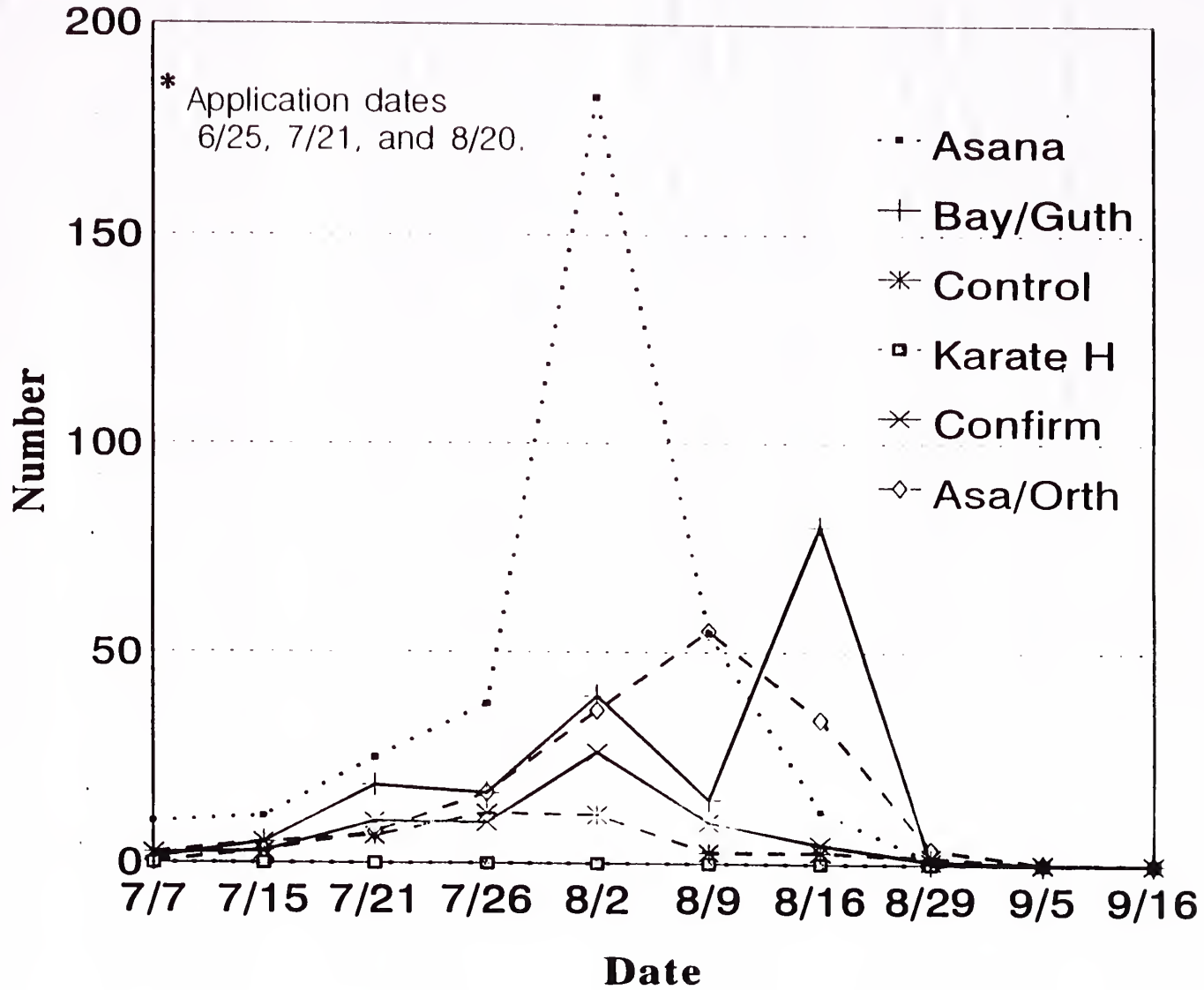
Treatment/form	Rate lb(AI)/a	% Bored Internodes	Moth emergence (NO./Stalk)[a]	% Kill (3 DAT) 6/28	7/24	8/23	AVG YSA per leaf	Lbs. sugar/acre
Asana 0.66EC	0.033	2.8a	0.10a	30.5ab	83.1c	93.3b	42.8c	6693b
Confirm 2F	0.125	3.1a	0.09a	63.4cd	61.6b	76.7b	6.8ab	6420b
Baythroid 2EC	0.016 +							
Guthion 2L	0.37	3.7a	0.10a	85.6d	88.3c	93.7b	22.4b	6893b
Karate 1EC	0.025	3.8a	0.13a	52.5bc	73.3bc	78.7b	0.8a	6649b
Karate 1EC	0.03	4.1a	0.15a	30.4ab	83.2c	86.7b	0.0a	6841b
Orthene 75S	0.18 +							
Asana 0.66EC	0.024	5.1a	0.12a	58.3bcd	80.0bc	75.0b	21.9b	6599b
Untreated check	---	42.0b	1.44b	3.3a	21.9a	18.4a	3.1ab	4834a
P>F(ANOVA)		0.0001	0.002	0.0005	0.0001	0.0001	0.002	0.001
LSD(0.05)		9.4	0.64	30.0	20.2	25.9	20.3	875

Means followed by same letter do not differ significantly (P=0.05,LSD). Application dates 6/25, 7/21, and 8/20.

[a]Based on a moth emergence of 75 stalks per plot.

Confirm treatment applied with CS-7 at a rate of .125%v/v 1st and 2nd application only.

Table 2. Average number of YSA per leaf for the season.



PATHOLOGY RESEARCH

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STALK ROT RESEARCH

The effect of drought stress on red rot, caused by *Colletotrichum falcatum,* was studied in a field experiment with seven varieties, CP 65-357, CP 70-321, CP 72-370, CP 73-351, CP 74-383, LCP 82-89, and LCP 85-384. The results were similar to an initial experiment. Across all varieties, there was no reduction in spring shoot populations due to inoculation without stress, populations were reduced by drought stress alone, and the lowest populations were in the treatment planted with inoculated stalks exposed to stress. The interaction between drought stress and red rot resulted in severe disease in all seven varieties.

The heritability of resistance to red rot was estimated from a field experiment including 40 crosses using 24 parents. Five progeny from each cross and the parents were inoculated, exposed to drought stress, and planted. Heritability, determined by mid-parent-offspring regression, was low. However, variability among replicates was high, and the experiment will be repeated with an altered experimental design. An additional problem is that clones with a high level of resistance are rare in the current breeding population. Basic germplasm sources will be screened to attempt to identify new sources of resistance to red rot.

Spring shoot populations and eventual stalk populations resulting from planting with whole stalks or billets were compared for five varieties, CP 65-357, CP 70-321, CP 72-370, LCP 82-89, and LCP 85-384. Spring shoot populations from whole stalk plantings were higher than those from billet plantings of CP 65-357, LCP 82-89, and LCP 85-384, and the populations in the billet plantings were higher for CP 70-321 and CP 72-370. Fall stalk populations were similar for CP 65-357, CP 70-321, and CP 72-370, whereas populations were still lower for billet platings of LCP 82-89 and LCP 85-384.

Experiments comparing plantings of whole stalks to billets have been conducted for three years. Conditions favoring severe disease do not occur every season, and results from different experiments have been variable. Spring shoot populations have been higher in whole stalk plantings in some years and higher in billet plantings in others for each of the varieties tested. Apparently, many experiments will be needed to assess the responses of different varieties to billet planting. For the 1995 experiment, a drought stress treatment was added.

This research has been expanded to include field experiments on a commercial farm using machine-cut billets. In addition, a highly vigorous clone, CP 85-800, is being compared with CP 70-321 and LCP 82-89. The results will be determined during 1995.

This project was partially funded by the American Sugar Cane League.

MOSAIC RESEARCH

Naturally occurring mosaic infection levels were monitored in varieties and experimental varieties planted in yield trials on farms (outfield tests) to evaluate levels of resistance to infection by sugarcane mosaic virus. The results of counts taken at five locations are shown in Table 1. Commercial varieties showing high susceptibility were CP 65-357 and CP 72-370. Increasing infection levels were detected in LCP 82-89, HoCP 85-845, and LCP 86-454. Infection level increases in the experimental varieties, CP 88-739 and CP 88-769, suggested these clones may be susceptible to infection by mosaic.

ROOT DISEASE RESEARCH

Research continued to determine the potential of soil amendments with various organic wastes to suppress Pythium root rot. Sewage sludge and cotton gin trash compost were the most consistent amendments for suppressing root rot and increasing plant growth. Sugar mill filter press cake, municipal yard waste compost, and bark compost amendments resulted in variable effects on root rot and plant growth. Amendments with municipal solid waste compost inhibited plant growth. The chemical and biological properties of the various organic wastes are being characterized. In a preliminary field experiment, sewage sludge amendment in second stubble increased yields of two varieties, LCP 82-89 and LHo 83-153. These results suggest soil amendments with organic wastes have promise to suppress root rot and increase sugarcane yield, and this research is continuing.

Additional research was conducted on the effects of herbicide applications and graminaceous weeds on the epidemiology of Pythium root rot. Across three experiments, applications of herbicides that are injurious to cane- glyphosate, pendimethalin (Prowl), and terbacil (Sinbar)- tend to result in increased colonization of roots by *Pythium*, increased symptom severity, and reductions in growth greater than those caused by herbicides or *Pythium* alone. The extent of root colonization by *P. arrhenomanes* was variable for different weeds grown in nonsterile field soil suggesting that graminaceous weeds may vary in their ability to serve as alternate hosts for the root rot pathogen. This research was conducted in cooperation with Dr. J. L. Griffin.

High populations of nematodes were detected at several locations on farms with cane exhibiting poor growth. Research has been initiated in cooperation with Dr. E. C. McGawley to compare the pathogenicity of different nematodes, the susceptibility of different varieties to nematode damage, and the interaction between Pythium root rot and nematodes.

LEAF SCALD RESEARCH

Additional surveys were conducted to monitor the distribution and extent of occurrence of leaf scald, caused by *Xanthomonas albilineans*. This disease was found at additional locations and in additional varieties on commercial farms and in the variety selection and variety release programs. Leaf scald is apparently widespread in the Louisiana sugarcane industry. However, the incidence of infected, symptomatic plants generally remains low.

Yield loss studies were conducted in two fields of LCP 82-89 and one field of HoCP 85-845. In one of the LCP 82-89 fields, yield was adversely affected by leaf scald. The number of stalks per acre, cane tonnage, and pounds of sugar per acre were inversely correlated with the incidence of leaf scald symptomatic plants. Coefficients of determination were 0.31, 0.33, and 0.33, respectively. No effect on yield could be detected in the other two fields.

The effect of leaf scald on individual stalk yield components also was studied in each of the three fields, and the results are shown in Table 2. Sucrose content and juice purity were lower in symptomatic compared to asymptomatic stalks in all three fields. Percent fiber was lower in symptomatic stalks from one field of LCP 82-89 and the field of HoCP 85-845. Stalk weights of symptomatic and asymptomatic stalks were similar in all three fields. This research was conducted in cooperation with Dr. M. P. Grisham of the USDA-ARS Sugarcane Research Unit.

YELLOW LEAF SYNDROME RESEARCH

Research conducted in other sugarcane growing regions has suggested that a disorder known as yellow leaf syndrome (YLS) might be caused by a virus. YLS is characterized by the yellowing of the midrib in young leaves as high as the fourth leaf on fully grown plants. On older leaves, the yellowing spreads into the leaf blade and a pinkish color may develop in the upper surface of the midrib. Eventually, leaves become prematurely senescent. Midribs of affected leaves also have a high sucrose content.

Leaves were collected from plants showing YLS-like symptoms from a total of five varieties- CP 70-321, LCP 82-89, LCP 85-384, HoCP 85-845, and CP 90-957- at a total of five locations. Brixing of midrib sap with a refractometer detected high sucrose concentrations in yellowed midribs of LCP 85-384, HoCP 85-845, and CP 90-957. Attempts were made to detect double-stranded RNA (a possible indication of virus infection) using two methods. In addition, root samples were collected from LCP 85-384 and HoCP 85-845. However, no dsRNA was detected in any sample. This research was conducted in cooperation with Dr. R. A. Valverde.

RATOON STUNTING DISEASE RESEARCH

Two field experments have been established to compare the rate of spread of ratoon stunting disease (RSD) in different sugarcane varieties at St. Gabriel and the USDA-ARS farm in Houma in cooperation with Dr. K. E. Damann and Dr. M. P. Grisham. The rate of disease spread will be compared in eight varieties- CP 65-357, CP 70-321, CP 72-370, CP 79-318, LCP 82-89, LHo 83-153, LCP 85-384, and HoCP 85-845. The experiments were harvested for the first time during 1994. Twenty stalks from every plot of each variety were collected and planted. Prior to the second harvest, the extent of infection in the previously disease-free material will be determined in the plant cane grown from the collected stalks and in the first stubble regrowth to compare rates of within-field and field-to-field spread of RSD in the different varieties.

SMUT RESEARCH

Resistance levels to smut, caused by *Ustilago scitaminea*, were determined in an inoculated test for experimental varieties in the selection program. The results are shown in Table 3. Three of four 1988-series clones were rated as moderately susceptible to smut while the fourth was rated as resistant. Two, one, and three of six 1989 series clones were rated as resistant, moderately susceptible, and highly susceptible, respectively. Four and six of 10 1990-series clones were rated as resistant and moderately susceptible, respectively. Four, three, and six of 13 1991-series clones and 18, seven, and nine of 34 1992-series clones were rated as resistant, moderately susceptible, and highly susceptible, respectively.

Table 1. Sugarcane mosaic virus infection levels and resistance ratings in commercial and experimental varieties determined from natural infection occurring in yield trials on farms (outfield tests).

Variety	Percent infection	Rating[a]	Experimental Variety	Percent infection	Rating[a]
CP65-357	84.0	9	HoCP88-739	11.1	2
CP70-321	6.9	1	CP88-769	7.1	1
CP72-370	74.8	8	L89-113	0.0	1
CP74-383	10.4	1	HoCP89-843	2.7	1
CP82-89	19.7	2	CP89-884	0.3	1
LHo83-153	0.2	1	CP89-888	0.4	1
LCP85-384	0.2	1			
HoCP85-845	5.7	1			
LCP86-454	18.9	2			

[a]Resistance ratings assigned on a 1-9 scale, in which 1-3 = resistant, 4-6 = moderately susceptible, and 7-9 = highly susceptible.

Table 2. Stalk yield components for leaf scald symptomatic compared to asymptomatic stalks.

		Stalk yield component[a]							
		Stalk wt. (lb)		Fiber (%)		Sucrose (%)		Purity	
Location	Variety	+	--	+	--	+	--	+	--
1	LCP82-89	1.7	1.7	11.3*	12.8	12.0*	14.6*	81.4*	85.7
2	LCP82-89	1.7	1.9	12.3	12.7	13.1*	15.3	84.6*	88.4
3	HoCP85-845	1.7	2.0	11.2*	12.7	11.9*	14.4	81.8*	86.3

[a] Yield components were determined from five replicates of ten stalks each. Values followed by an asterisk were significantly different from the other value for the same yield component and location. The + = symptomatic stalk values, and -- = asymptomatic stalk values.

Table 3. Smut infection levels and resistance ratings determined from the 1994 inoculated test.

Variety	Infection (%)	Rating[a]	Variety	Infection (%)	Rating[a]
CP65-357	16.8	4	L91-230	42.8	8
CP70-321	0.0	1	L91-232	5.2	3
CP73-351	6.9	3	L91-250	7.1	3
CP74-383	33.5	6	L91-255	24.9	5
CP81-335	37.6	7	L91-261	37.7	7
LCP82-89	0.0	1	L91-264	40.2	7
LHo83-153	30.7	6	L91-266	87.5	9
LCP85-384	3.1	2	L91-276	75.2	9
LCP86-454	14.8	4	L91-281	7.3	3
L88-46	22.9	5	L91-285	0.0	1
L88-63	31.3	6	L91-286	20.6	5
HoCP88-739	0.3	2	L91-288	34.8	7
CP88-769	27.0	6	L91-290	31.3	6
L89-113	36.7	7	L92-291	30.9	6
HoCP89-843	0.0	1	L92-292	4.8	2
HoCP89-846	52.4	9	L92-293	26.7	6
CP89-884	23.0	5	L92-295	53.8	9
CP89-888	57.8	9	L92-299	2.9	2
Ho89-889	8.4	3	L92-301	0.0	1
L90-178	11.1	4	L92-303	34.7	7
L90-191	10.1	4	L92-304	4.8	2
HoCP90-923	1.8	2	LHo92-307	2.8	2
CP90-935	11.8	4	L92-309	13.6	4
CP90-936	28.7	6	L92-310	9.8	3
HoCP90-941	2.5	2	L92-311	46.1	8
CP90-955	0.0	1	L92-312	7.9	3
HoCP90-957	28.1	6	L92-313	16.9	4
HoCP90-963	0.0	1	LHo92-314	0.5	2
HoCP90-977	26.9	6	L92-315	4.5	2
L92-317	2.7	2	L92-334	0.0	1
L92-318	8.9	3	L92-335	51.3	9
L92-319	11.4	4	L92-337	49.8	8
L92-321	1.3	2	L92-342	18.3	5
L92-322	66.0	9	L92-349	0.0	1
L92-323	6.0	3	L92-351	13.9	4
L92-328	70.6	9	L92-353	44.4	8
L92-329	42.9	8	L92-355	6.1	3
L92-333	3.9	2	L92-356	5.3	3

[a] Resistance ratings assigned on a 1-9 scale, in which 1-3 = resistant, 4-6 = moderately susceptible, and 7-9 = highly susceptible.

SUGARCANE PATHOLOGY RESEARCH

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There are four areas in which progress has been made in understanding disease and disease causing organisms in sugarcane.

First, a polymerase chain reaction (PCR) assay has been developed for detecting *Xanthomonas albilineans* (Xa), the cause of leaf scald disease, and *Clavibacter xyli subsp. xyli* (Cxx), the cause of ratoon stunting disease (RSD) of sugarcane.

Second, infectivity titration assays performed on commercial cultivars in the greenhouse have been used to determine their susceptibility to leaf scald disease. These results appear to agree with anecdotal evidence from field observations and field experiments to rate varietal resistance.

Third, isolates of Xa have been produced which bioluminesce or produce their own light. This is a useful feature for monitoring and estimating populations of this organism.

Fourth, an extension of previous work with *Ustilago scitaminea*, the sugarcane smut fungus, has shown that the stable non-polymorphic electrophoretic karyotype of Louisiana isolates can be distinguished from karyotypes of Japanese and Brazilian isolates. All of these results have implications which will be discussed.

PCR DETECTION OF LEAF SCALD AND RATOON STUNTING DISEASE

These two diseases are difficult to detect because in the first case the disease can be latent i.e. not showing the 'white line' symptoms and in the second case RSD is cryptic with no external symptoms. Serological assays to diagnose these diseases typically require approximately 10^5 or 100,000 cells of the bacterium for a positive result. The slow growth of the bacterial population in the host plant means that high enough populations for detection occur late in the growing season. In an effort to improve our ability to detect lower numbers of these bacteria earlier in the growing season, my student Silvio Lopes and I have used the polymerase chain reaction.

Our initial work involved rDNA spacer consensus primers that amplified a 500bp product from both the RSD and Xa bacteria. Thus this primer set was not useful for distinguishing between the two diseases. Our next effort used t-RNA spacer consensus primers. These primers amplified a 300bp product from Cxx and a 150bp product from Xa. These primers were then used to identify and distinguish the two diseases.

Working with vascular extracts from diseased plants we can regularly detect as few as 2000 bacteria, which represents a 50-fold improvement in sensitivity over serological methods

and should allow detection of these diseases earlier in the growing season. We have also developed an Immunocapture technique coupled to PCR in the same 96-well microplate, which facilitates sampling of large numbers of plants.

INFECTIVITY TITRATION FOR LEAF SCALD RATINGS

The infectivity titration experiments were performed by Silvio Lopes in cooperation with Dr. Jeff Hoy and are based on the assumption that inoculation with a higher concentration of the bacterium causes a greater frequency of disease among a uniformly inoculated population. By inoculating a different population of each cultivar with one of three different concentrations of Xa, different frequencies of disease occur among the three populations. Disease frequency was determined by symptom expression, PCR, and selective plating.

It is possible to use these 3 frequencies of disease for each cultivar to establish an ED-50 or concentration of bacteria theoretically required to infect only 50% of the inoculated plants of a particular cultivar. By comparing ED-50s among different cultivars it is possible to rank them from most susceptible to most resistant. The results of the first greenhouse infectivity titration were in line with field ratings of commercial cultivars and identified CP 74-383, LCP 82-89, and HoCp 85-845 as being among the most susceptible to leaf scald.

BIOLUMINESCENT XANTHOMONAS ALBILINEANS

The leaf scald bacterium was transformed by electroporation using a plasmid bearing a transposon with a promoterless LUX cassette and a tetracycline resistance selectable marker. This resulted in the "jumping" of the transposon into the genomic DNA of the bacterium which was selected for ability to grow on a tetracycline containing medium. Not all resistant colonies produced light observable to the naked eye so some visual selection for brightly glowing colonies was necessary. Those were tested for pathogenicity in a sweet corn bioassay and the brightest pathogenic isolate was inoculated into the highly susceptible CP 74-383 and the resistant LCP 85-384 and 15 of their progeny. These were supplied by Scott Milligan. The experiment is continuing in the greenhouse. I have shown that 10-fold dilutions of this bioluminescent isolate can be detected over 3 orders of magnitude (1,300-1,300,000 cells) using a scintillation counter to measure the light output. A graph of colony forming units versus light output in counts per minute forms a straight line and thus suggests that the number of cells can be directly estimated by light output.

This should facilitate the estimation of population sizes of this bacterium in vascular extracts of the parents and progeny inoculated with the bioluminescent transformant in the greenhouse. This will allow rapid screening for resistance and susceptibility to leaf scald in the breeding program and make estimates of rate of spread by the harvester much easier to determine.

SUGARCANE SMUT ELECTROPHORETIC KARYOTYPE

I have discovered that the electrophoretic karyotype of Louisiana isolates of the sugarcane smut fungus *Ustilago scitaminea* collected over a 10-year period (1981-1990) appears to lack

polymorphisms in chromosome number and size i.e, they are identical in having 17 chromosomes totalling 13.7Mb of DNA, which makes them readily identifiable. When I compared them with the electrophoretic karyotypes of Brazilian or Japanese isolates there were polymorphisms in chromosome size and number that makes them different from our isolates.

There is an interesting ramification of this discovery that I am pursuing. The geographic origin of the original inoculum introduced into Louisiana prior to 1981 may be identifiable by finding the same electrophoretic karyotype in isolates from another geographic area, i.e. the source. There are at least two theories concerning the origin of inoculum in Louisiana. One suggests a source from points south in Central America or the Caribbean, which mimics the historical path of spread of the disease in its northward progression from Argentina in 1940. A second theory suggests that spores were blown westward across the Atlantic Ocean from S. Africa to Louisiana several years prior to its appearance here. In an attempt to answer this question I have obtained the world collection of smut isolates from the USDA. I now have numerous isolates from all over the world, which will allow me to search for a karyotype that matches the Louisiana pattern. There are also opportunities to compare the Florida and Texas isolates as well.

The work also has the potential for identification of pathogenic races of the smut fungus if they should arise. Others working on barley smut have shown that each of 14 races has a different electrophoretic karyotype.

WEED CONTROL RESEARCH IN SUGARCANE

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In 1994, experimental and labeled herbicides were evaluated for sugarcane tolerance and control of Italian ryegrass (*Lolium multiflorum* Lam.), johnsongrass (*Sorghum halepense* L. Pers.), and bermudagrass (*Cynodon dactylon* L. Pers.). The project personnel are appreciative of funding from the American Sugar Cane League and cooperation of Mike Melancon, Ronnie Roberts, and Alfred Guidry (St. Martin Parish); Joe Beaud, David Stewart, Steve and Chuck Loupe, and Miles Brashier (Pointe Coupee Parish); Ed Richard (Terrebonne Parish); Lee Allee and Jimmy Garrett (St. James Parish); Stan and David Rodrigue and Larry Brock (St. John Parish); Donnie Vaughn and John Roy (East Baton Rouge Parish); and Robert Morris and Harry Laws (West Baton Rouge Parish). Below is a summary of research results.

RESEARCH WITH NEW HERBICIDES

Experimental herbicides F-6285 (Authority), RH 1658, Goal, MON 12000, and CGA 152005 were evaluated. Sugarcane tolerance to all herbicides applied postemergence overtop in spring was acceptable. MON 12000 provided impressive control of nutsedge. F-6285 controlled morningglory preemergence and postemergence equivalent to that of atrazine. Goal and CGA 152005 showed promise for postemergence morningglory control.

RYEGRASS RESEARCH

Presence of ryegrass in sugarcane in spring can delay field activities and interfere with mechanical tillage and herbicide application. Research was conducted at three locations to evaluate atrazine (1.5 qt/A), Karmex/Direx (3.6 lb product/A), and Gramoxone Extra (1.0, 1.5, and 2.0 pt/A) applied in January, February, or March alone and in mixtures. Data collected from these studies were submitted to EPA by Zeneca, the manufacturer, and a state label was granted for use of Gramoxone Extra prior to sugarcane emergence in spring.

St. Martin Parish. Based on ryegrass control in early April, Gramoxone Extra was generally more effective when applied February 18 than January 14. Gramoxone Extra applied in February at 2.0 pt/A controlled ryegrass 85 to 95%, and 86% when applied March 15. This compares with no more than 22% for Sencor (3.1 lb product/A), Sinbar (1.6 lb product/A), or atrazine applied in March. Sugarcane shoot population determined April 30 was 44 to 47% greater when Gramoxone Extra was applied in February at 1.5 or 2.0 pt/A compared with atrazine applied in March.

East Baton Rouge Parish. Ryegrass control in early April was at least 88% when Gramoxone Extra was applied February 18 regardless of rate. Gramoxone Extra plus atrazine applied March

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This project was partially funded by the American Sugar Cane League.

15 controlled ryegrass 87%, which was greater than for the standard treatments of Sencor, Sinbar, or atrazine applied the same time. Sugarcane shoot population and sugarcane height in May were similar for all herbicide treatments.

Pointe Coupee Parish. Ryegrass control 26 days after the February 21 application was enhanced when Karmex was added to Gramoxone Extra at 1.5 and 2.0 pt/A compared with Gramoxone Extra applied alone. This response was also apparent when control ratings were made April 1. Gramoxone Extra plus Karmex controlled ryegrass 93% whereas Gramoxone Extra alone controlled no more than 62% of ryegrass. Gramoxone Extra applied with Karmex in March provided 80% ryegrass control. Sugarcane shoot populations in May were at least 21% greater when Gramoxone Extra plus Karmex was applied in February compared with Karmex alone. Sugarcane height in August and sugar yield were equivalent for all treatments.

Gramoxone Sugarcane Tolerance Study. Sugarcane injury was more severe when Gramoxone Extra was applied April 4 than March 18. Sugarcane injury 26 days following the April application of Gramoxone Extra at 2 pt/A was 25%. Even so, sugarcane injury was not reflected in reduced sugarcane shoot population or height in August. Sugarcane and sugar yields were not negatively affected by the March or April Gramoxone application.

ASULOX RETURN ON INVESTMENT STUDY

The objective of this study was to determine the effect of Asulox application on johnsongrass control, sugarcane fiber content, and sugar recovery. Asulox was applied at 4 qt/A on April 29, May 19, April 29 followed by June 17, or June 17. A no Asulox treatment was included for comparison. Johnsongrass control in mid-July was 74% when Asulox was applied in mid-May and 63% when applied in mid-June. Sugarcane height and stalk population in late August were greater when Asulox was applied in late April than in mid-May. At harvest, only half of each plot was burned. Sugarcane and johnsongrass from burned and nonburned plots were separated by hand and each component weighed. Sugarcane and johnsongrass were chipped and reconstituted based on the percent of each component and fiber and TRS were measured using conventional core press analyses. When sugarcane was not burned, fiber was less when Asulox was applied April 29, May 19, or April 29 followed by June 17 than when no Asulox was applied. Sugar yield in nonburned plots when Asulox was applied April 29 and April 29 followed by June 17 was 1.8 and 2.0 times greater, respectively, than when Asulox was not applied. When sugarcane was burned, only the April followed by June applications reduced fiber. Sugar yield in the burned sugarcane was 1.6 and 2.0 times greater when Asulox was applied in May or April followed by June, respectively, than when Asulox was not applied.

Results suggest that return on investment from use of Asulox should not be based on visual johnsongrass control, but rather on the positive benefits in lower fiber in sugarcane delivered to the mill and increased sugar recovery. Asulox application was beneficial whether or not sugarcane was burned.

ROUNDUP HOODED SPRAYER TEST

Roundup 4L was applied at 2.5, 3.0, 3.5, and 4.0 qt/A under a hooded sprayer on April

26. Bermudagrass control with the Roundup treatments 10 days after application ranged from 84 to 93%. Roundup at 3.5 and 4.0 qt/A controlled bermudagrass more than when 2.5 qt/A was applied. Sugarcane visual injury was not noted. On July 18, bermudagrass ground cover was 90% for the untreated check but no more than 32% for the Roundup treatments. Even so, sugarcane stalk population determined in August and sugarcane and sugar yields following Roundup treatments were not increased over that for the untreated check.

JOHNSONGRASS RESEARCH

Johnsongrass Control in Succession Planted Sugarcane. Oust, Sencor, or Sinbar was applied after CP 72-370 was succession planted October 14, 1993. Johnsongrass control in December ranged from 93 to 98% and was similar for all rates of Oust (1, 2, or 3 oz/A). Sencor (2.4 lb product/A) and Sinbar (1.8 lb product/A) controlled johnsongrass no more than 43%. Sugarcane shoot population in January was reduced when Oust was applied at 3 oz/A after planting. In May, johnsongrass control with Oust was 78 to 94%, and application of Prowl plus atrazine (7.3 pt/A + 1.9 qt/A) or Sencor (3.1 lb product/A) in spring did not enhance johnsongrass control over that of Oust alone. Johnsongrass control in May with the Oust treatments was sufficient enough that application of Asulox (4 qt/A) was not needed. Any differences in sugarcane shoot populations observed in January were not apparent in May. Compared with the standard treatment of Sencor after planting and Prowl plus atrazine in the spring, sugarcane height in August was reduced when Oust was applied after planting only at 3 oz/A. Even though johnsongrass was controlled with the Oust treatments, sugarcane yield was no more than 21 tons/A, which is considerably less than what would be expected in plant cane following a standard fallow program.

Johnsongrass Control in Sugarcane Harvested for Seed. Sugarcane was harvested for seed on August 26, 1993, and herbicide treatments were applied immediately after harvest. Johnsongrass control 21 days after treatment was 71, 76, and 87% for Oust at 1, 2, and 3 ounces product/A, respectively. Sinbar, Sencor, Prowl plus atrazine, and atrazine alone controlled johnsongrass no more than 36%. Johnsongrass control with the Oust treatments 64 days after application was no more than 69%. Asulox applied postemergence September 17 controlled johnsongrass 72% 41 days after treatment. Sugarcane emergence in spring was not negatively affected by Oust application, but johnsongrass control was similar to that noted in plots not treated with Oust.

Johnsongrass Control With Roundup Under Simulated Rainfall. Studies were conducted July 19 and July 26, 1994 to evaluate rainfastness of Roundup D-Pak and spray additives in respect to rhizome johnsongrass control. Plots received either no rainfall or rainfall at 15 or 60 minutes after herbicide application using a rainfall simulator delivering 0.5 inch of water in 15 minutes. Herbicide treatments included Roundup D-Pak at 30 oz/A with Kinetic HV at 0.25% (v/v), Break-Thru at 0.15% (v/v), or Induce at 1.0%.

In the first study, herbicide treatments were applied to rhizome johnsongrass 20 to 36 inches tall. At 14 days after treatment, johnsongrass control increased as washoff time was delayed. Johnsongrass control was enhanced with the addition of Break-Thru at the 15-minute washoff and Kinetic HV at the 60-minute washoff when compared with the Induce standard. For the no-washoff treatment, johnsongrass was controlled 81 to 90%, and differences among

adjuvants were not noted. Johnsongrass control following washoff at 60 minutes, regardless of adjuvant, was no more than 64% and less than for the no-washoff treatments. Regardless of differences in control, johnsongrass regrowth 44 days after treatment was comparable for the adjuvant/washoff treatments and in all cases was less than for the untreated check.

In the second study, rhizome johnsongrass was 12 to 40 inches tall when herbicide treatments were applied. At 14 days after treatment, johnsongrass control increased as washoff time was delayed. Johnsongrass control was enhanced with the addition of Break-Thru and Kinetic HV at the 15 minute washoff compared with the Induce standard. For the 60-minute and no-washoff treatments, johnsongrass control was equivalent and ranged from 44 to 60%. Based on johnsongrass ground cover, regrowth 44 days after treatment in most cases was equivalent for the adjuvant/washoff treatments and less than for the untreated check.

Johnsongrass Control With Roundup D-Pak and Additives. Field studies were conducted to evaluate effectiveness of various additives with Roundup D-Pak at 20 oz product/A for rhizome johnsongrass control. In all studies, johnsongrass was 20 to 60 inches tall with 5% of the panicles emerged when herbicide treatments were applied.

In the first study, johnsongrass control 14 days after treatment was 93% for Roundup D-Pak plus Silwet L-77 (0.125% v/v) plus ammonium sulfate and 90% for Roundup D-Pak plus LI 700 (0.50% v/v) plus ammonium sulfate. When Roundup D-Pak was applied with only LI 700, johnsongrass control was less than when ammonium sulfate was also added to the spray mixture. The Roundup D-Pak plus MSO (1.0% v/v) treatments when ammonium sulfate was not included controlled johnsongrass 76 to 79%. Roundup D-Pak plus MSO plus Silwet L-77 plus ammonium sulfate provided 86% johnsongrass control.

In the second study, johnsongrass control 7 days after treatment with silicone adjuvants Break-Thru, Silwet L-77, and Silwet 408 all at 0.125% v/v was no higher than 73% but was equivalent to that observed with the Induce standard at 1.0% v/v. At 14 days after treatment, johnsongrass control for all adjuvants was equal to that of Induce (76%). Addition of 2,4-D (16 oz product/A) plus Induce significantly reduced johnsongrass control compared with Induce alone. Differences in johnsongrass regrowth were not noted among the herbicide treatments, but regrowth for all treatments was less than for the untreated check.

In the third study, Roundup D-Pak plus Herbex (0.125% v/v), Silwet L-77 (0.125% v/v), HM 9207A (0.50 v/v), Activator 90 (1.0% v/v), LI 700 (0.50% v/v), or LI 700 plus ACA (1 oz product/A) at 14 days after treatment provided 68 to 78% johnsongrass control, which was greater than the Induce standard (50%). Addition of 2,4-D plus Induce did not reduce control compared with Induce alone. No regrowth differences were noted among the herbicide treatments, but regrowth for all was less than for the untreated check.

BERMUDAGRASS RESEARCH

Roundup, Oust, and Tillage Fallow Programs. Field studies were conducted to evaluate bermudagrass control programs in fallow fields. Tillage at four-week intervals with or without Roundup 4L at 2 or 3 qt/A was implemented May through August. Included for comparison

was Oust applied preemergence June 1 at 2.8 oz product/A to freshly tilled and packed beds and a tillage only treatment. To further evaluate effectiveness of the Roundup/tillage treatments, Sinbar (2.4 lb product/A) or atrazine (1.9 qt/A) was applied after planting in September and Lexone (3.1 lb product/A) or Prowl plus atrazine (7.3 pt/A + 1.9 qt/A) was applied in February the following year.

Based on ground cover ratings two weeks prior to planting in September, plots receiving Roundup plus tillage had no higher than 2% bermudagrass ground cover, significantly less than the 9% observed with tillage alone. Although Oust provided excellent control of bermudagrass for around 50 days, plots were completely covered with bermudagrass in September. In May of the following year, bermudagrass ground cover was 54% in Oust plots and 47 and 32% in Roundup plus tillage plots that received atrazine after planting and Prowl plus atrazine in spring. In contrast, when Sinbar was applied after planting and Lexone in February, bermudagrass ground cover was no more than 5%. Although differences in bermudagrass control were noted, CP 70-321 sugar yields were similar for the herbicide/tillage treatments.

Bermudagrass Control in Succession Planted Sugarcane. Oust at 1, 2, and 3 oz product/A was compared with standard treatments of Sinbar (1.8 lb product/A) or Sencor (2.4 lb product/A) alone or plus Oust (1.5 oz product/A), and atrazine alone (1.9 qt/A) when all were applied preemergence after succession planting of sugarcane in December. Based on bermudagrass ground cover ratings in March the following year, plots receiving Oust alone and in mixture with Sinbar were covered with 20 to 38% bermudagrass, which was equivalent to the 30% observed with Sinbar alone. Sencor alone or in combination with Oust provided less bermudagrass control than that of Oust alone or plus Sinbar. Lowest bermudagrass control was observed when atrazine was applied (100% ground cover). Ground cover ratings in July indicated that Oust alone or with Sinbar provided equal bermudagrass control and ground cover was no more than 16%. Highest bermudagrass infestation in July occurred when Sencor or atrazine was applied (approximately 50% ground cover). Sugarcane stalk population and height in August when Oust was applied alone were equivalent to when Sinbar was applied alone or with Oust. Sugar yields with Oust applied alone were equal to Sinbar alone or plus Oust. When atrazine was used, CP 65-357 sugar yield was 11% less than when Sinbar was applied alone.

SUGARCANE TOLERANCE TO OUST

To evaluate sugarcane tolerance, Oust was applied at 2 oz product/A 45 days prior to planting and immediately after planting of LCP 82-89, CP 72-370, CP 70-321, CP 65-357, and LCP 85-384. Of the cultivars, CP 72-370 appeared more susceptible to injury when Oust was applied after planting. None of the cultivars was injured when Oust was applied 45 days prior to planting. This study is in progress, and sugarcane shoot counts in spring and yields will be determined.

HERBICIDE RESEARCH IN TRANSPLANTED SUGARCANE SEEDLINGS IN 1994

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in cooperation with
St. Gabriel Research Station

SUMMARY

An experiment was conducted in 1994 to test herbicides on the plant survival rate and weed control in transplanted sugarcane seedlings. The seedling plants were grown in a greenhouse from true seed and transplanted in field plots in April, 1994. Sencor was applied at an X rate and a 2 X rate prior to planting, and a combination of Atrazine + Prowl was applied at an X rate prior to planting and at X and 2 X rates after planting the seedlings. The percent plant survival and weed control were recorded on the treated plots and a check plot several weeks after planting the seedling plants.

The results show that Sencor at each rate applied prior to planting gave an excellent grass and broadleaf weed control but reduced the percent plant survival to an unacceptable level. The Atrazine + Prowl combination at each rate applied before and after planting gave an acceptable weed control of at least 90% and did not affect the plant survival and population in transplanted cane seedlings.

OBJECTIVES

The research was initiated to evaluate herbicides for plant survival rate and percent weed control in transplanted sugarcane seedlings.

RESULTS AND DISCUSSION

An experiment was conducted in 1994 to test the effects of rates of Sencor, Atrazine, and Prowl herbicides on the plant survival rate and weed control in transplanted sugarcane seedlings. The test was located on a Commerce soil on the St. Gabriel Research Station. Seedling plants were grown in a greenhouse from true seed obtained from several parental crosses in the LSU Sugarcane Breeding program. The seedlings were transplanted in the field 16 inches apart on one-row plots, 150 feet long in April, 1994. Sencor was applied on plots at an X rate and 2 X rate before the cane seedlings were transplanted in the field. Atrazine and Prowl were applied on the same plots at an X rate before planting and at an X rate and 2 X rate after planting and irrigating the seedlings. The X rate is the recommended rate normally used in cane and the 2 X rate is twice the recommended rate applied on a 36-inch band. Normal cultural practices and irrigation as needed were applied to all the plots during the growing season.

The number of dead and live seedling plants was recorded on the treated plots and a check plot two and four weeks after transplanting. Also, the percent control of grass and

broadleaf weeds was determined after four weeks. The data obtained in the experiment are reported in Table 1.

The results show that 12.8% of the seedling plants on the check plot were dead four weeks after transplanting apparently due to natural causes. The Sencor herbicide at each rate applied before transplanting reduced the plant population but gave excellent weed control. The population was reduced 29.8% with the X rate and 44.2% with the 2 X rate of Sencor. This reduction due to herbicide injury is not acceptable in a seedling program.

The Atrazine + Prowl herbicide combination at the X rate applied before and after transplanting did not affect the survival rate of the seedlings. The 2 X rate was higher than the X rate in percent dead plants but well below the check plot. All the Atrazine + Prowl treatments gave excellent plant survival rates and acceptable control of grass and broadleaf weeds.

Generally, the results show that the application of Atrazine and Prowl before or after planting was safe to use in transplanted cane seedlings. Since Atrazine controls mostly broadleaf weeds and Prowl controls grasses, it is important to use a combination of the two herbicides for good weed control. The application of Atrazine + Prowl combination at an X rate before planting and when needed after planting could probably improve weed control with a highly acceptable plant survival rate. Sencor gave excellent grass and broadleaf weed control, but the plant survival rate is not acceptable even with the X rate before planting. It is possible that a 1/2 X rate of Sencor prior to planting could give an acceptable weed control and plant survival rate, but this was not tested in this experiment and needs further study.

Table 1. Effect of rate and time of herbicide application on transplanted sugarcane seedlings and weed control on the St. Gabriel Research Station in 1994.

Herbicide Applied	Time Applied	Rate Applied	Total seedling planted	Percent seedlings dead after		Percent weed control after 4 weeks	
				2 weeks	4 weeks	Grass	Broadleaf
			No./plot	%	%	%	%
Check	--	--	128	7.8	12.8	0	0
Sencor	Pre-plant	X	128	16.5	29.8	98	100
	Pre-plant	2X	127	27.6	44.2	98	100
Atrazine + Prowl	Pre-plant	X	127	3.6	6.3	95	90
	Post-plant	X	129	2.4	5.4	90	90
	Post-plant	2X	127	4.8	9.5	95	95

X Rate is 1.5 pts/A for Sencor, 2.0 pts/A for Atrazine and 1.5 pts/A for Prowl. Pre-plant application was before and post-plant was after planting seedlings.

SOIL FERTILITY RESEARCH IN SUGARCANE IN 1994

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in cooperation with
St. Gabriel Research Station and W. B. Hallmark and
L. P. Brown at the Iberia Research Station

SUMMARY

Six field experiments were conducted in 1994 to test the effects of rates and time of fertilization on the yield components of sugarcane grown on different soil types. The experiments were in fallow and succession planted cane with the newer cane varieties. Results from a test with rates of NxPxK plus S and fall fertilizer treatments on a Baldwin clay soil show that cane yields were increased with 80 lbs/A N and from 160 over 80 lbs/A N and from 80 lbs/A of potash. The P, S, and fall-applied fertilizer did not increase yield. In an NxPxK test plus S and lime treatments on a Coteau soil, the cane and sugar yields in plant cane were increased with 80 lbs/A of potash. The check plot yield was relatively high, and the yield increases from the different treatment combinations were small.

In experiments on Commerce soil, fall- and spring- applied NPK fertilizers were tested in fallow and succession planted cane. Plant cane yields were increased from an N spring rate, but not from NPK over the N rate in both types of cane. Also, plant cane yields were increased with a fall applied 45-45-45 starter fertilizer in fallow cane and with a 15-45-45 and 45-45-45 starter fertilizers in succession cane. In first stubble cane, the average yields were increased with an NPK spring rate over N alone and with a 45-45-45 fall starter fertilizer in fallow and succession cane. A 90-90-90 fall rate did not improve yield over the lower rates in each test. Furadan tested in succession cane increased yields in plant cane, and the increase was close to significance in stubble cane.

OBJECTIVES

This research was designed to provide information on soil fertility in an effort to help cane growers to produce maximum economic yields and to increase profitability in sugarcane production. This annual progress report is presented to provide the latest available data on certain practices and not as a final recommendation for growers to use all of these practices. Recommendations are based on several years of research data.

RESULTS AND DISCUSSION

Six experiments were conducted in 1994 at several locations to test the effects of rates

This research was supported in part by grant funds from the American Sugar Cane League.

of fertilization on the yield of fallow and succession planted sugarcane. The fallow cane was planted after a fallow year in a normal cane rotation, and the succession cane was planted immediately after harvesting a stubble cane crop without a fallow year.

Rates of N, P, K, and S Fertilizers

An experiment was continued to test rates of N, P, K, and S fertilizers on yield of first stubble cane on a Baldwin clay soil on the Iberia Research Station. The rates consisted of 80, 160, and 240 lbs/A of N, 0, and 60 lbs/A of phosphate and 0 and 80 lbs/A of potash in all possible combinations. In addition a fall-applied 90-90-90 NPK fertilizer and a 24-lbs/A rate of sulfur were tested with some of the NPK treatments. The fall fertilizer was applied in the planting furrow. The first stubble yield data obtained at harvest time are reported in Table 1. The cane and sugar yields per acre from 80 lbs/A of N and from all NPK treatment combinations were significantly higher than the check plot yield. The yields from 160-0-80, 160-60-80, and 240-0-80 treatments were higher than yields from 80 lbs/A of N alone. The yield increases from the fall applied NPK and sulphur were small. A factorial analysis of the data showed that N rates above 80 lbs/A increased the cane yield, sugar yield, and stalk population. Also, the phosphate rate tested increased stalk population, and the potash rate increased the cane yield per acre. The factorial mean effects of N, P, and K fertilizers on percent brix and sucrose in the cane juice were small.

Rates of N, P, K, and S Fertilizers and Lime

An experiment was initiated to test rates of N, P, K, and S fertilizers and dolomite lime on the yield of plant cane on Viator Farm on a Coteau sil soil in Lafayette Parish. The rates consisted of 80, 160, and 240 lbs/A of N, 0, and 60 lbs/A of phosphate and 0 and 80 lbs/A of potash in all possible combinations. In addition, a 24-lbs/A rate of sulphur and a 1 T/A rate of dolomite lime were tested with one fertilizer treatment. The lime rate was broadcasted and incorporated into the soil in one treatment and applied in the planting furrow in another treatment. The yield data obtained in 1994 are reported in Table 2.

The results show that the effects of each treatment combination on the yield components of plant cane in this test were small. The cane and sugar yields on the check plot were relatively high (32.0 T/A). However, a factorial analysis of the NPK data showed that the 80 lbs/A rate of potash tested significantly increased the cane yield, stalk population and sugar yield per acre.

Starter Fertilizer in Plant Cane of Fallow Planted Cane

An experiment was initiated to test the effects of NPK fertilizer rates applied as a starter fertilizer in the fall at planting time in addition to spring-applied fertilizers in fallow planted cane. The starter fall rates tested were 0-0-0, 15-45-45, 45-45-45, and 90-90-90 lbs/A of NPK. Spring rates consisting of 120-0-0, 120-0-80, and 120-40-80 were applied over each fall rate. The test was planted with CP 70-321 after a fallow year, and the fall treatments were applied in the planting furrow. The spring treatments were applied in the off-bar furrow in plant cane in 1994. The data obtained in plant cane are reported in Table 3.

The results show that the N and NPK spring treatments without fall fertilizer increased the cane yield, stalk number, and sugar yield per acre. The mean effect data show that the differences in yield components between the N and NPK spring rates were small. The average cane yield was increased with the fall applied 45-45-45 fertilizer, and the average sugar yield was increased with the fall 15-45-45 fertilizer. Higher fall rates did not improve cane yields. This shows that a starter fertilizer applied in the planting furrow with only N fertilizer in the spring can increase plant cane yields from cane planted after a fallow year.

Starter Fertilizer in Plant Cane of Succession Planted Cane

An experiment was initiated to test the effects of NPK fertilizer rates applied as a starter fertilizer in the fall in addition to spring applied fertilizers on the yield of succession planted cane. The starter fall rates were the same as in the above fallow planted test. Spring rates consisting of 0-0-0, 120-0-0, 120-40-80, and 120-40-80 + Furadan were applied over each fall rate. The test was planted with LCP 85-384 in succession immediately after harvesting a cane crop in 1993. The fall treatments were applied in the planting furrow and the spring treatments in the off-bar furrow in 1994.

The data obtained in plant cane are reported in Table 4. The results show that N and NPK spring treatments increased cane yields with each fall rate except with the 90-90-90. The Furadan increased cane yield with the 15-45-45 fall rate. The fall rates without additional fertilizer in the spring increased cane yields 11.8% with 15-45-45, 29.0% with 45-45-45 and 49.8% with 90-90-90. The mean effect data show that the cane yields from the 15-45-45 and 45-45-45 fall rates were similar but higher than the check plot and lower than the 90-90-90. Also, the cane yields from the N and NPK spring rates were similar but higher than the check and lower than the NPK + Furadan. This shows that the yields of succession plant cane can be increased with a starter fertilizer applied at planting time and with Furadan especially at a low starter fertilizer rate.

Starter Fertilizer in First Stubble Cane of Fallow and Succession Planted Cane

An experiment was continued from plant cane in 1992 to test the effects of starter fertilizers applied in the fall- and spring- applied fertilizers on the yield of first stubble from fallow and succession planted cane. The fallow cane was planted after a fallow year and the succession cane was planted immediately after harvesting a cane crop in 1992. Variety LCP 82-089 was planted on the same date in early November for both types of cane. The fall fertilizer rates tested were 0-0-0, 45-45-45, and 90-90-90 lbs/A of NPK. Spring rates of 120-0-0 and 120-40-80 were tested with each fall rate. Also, Furadan was tested in the succession cane. The fall rates were applied in the planting furrow in 1992, and the spring rates were applied in the off-bar furrow in plant and first stubble cane.

The first stubble yield data obtained from the fallow planted part of the experiment are reported in Table 5. The results show that the cane yields were increased from the NPK over N spring rates with each fall rate. Also, cane yields were increased from each fall rate with N and NPK applied in the spring. The mean data show that the cane yield with the 45-45-45 fall rate was higher than the check and the 90-90-90 rate. The cane yield was higher with the NPK

than the N spring rate. This shows that the highest yield of first stubble from planting after a fallow were produced with a 45-45-45 starter fertilizer plus 120-40-80 applied in the spring.

The first stubble yield data obtained from the succession part of the experiment are reported in Table 6. The results show that the cane yields were increased from the NPK over N spring rate with each fall applied rate. The mean data show that the cane yield with the 45-45-45 fall rate was higher than the check and the 90-90-90 rate. The cane yields were higher with N spring rate than the check and higher with NPK than the N spring rate. The yield increases from Furadan were close to significance, especially at the low fall rate. This shows that the highest yield of first stubble succession cane was produced with a 45-45-45 starter fertilizer plus 120-40-80 + Furadan in the spring.

Table 1. Effect of rate of fertilizer application on the yield of first stubble on a Baldwin clay soil on the Iberia Research Station in Iberia Parish, 1994.

Fertilizer applied	First stubble	Stalk		Normal Juice		Sugar
$N-P_2O_5-K_2O$	yield	No.	Wt.	Brix	Sucrose	yield
lbs/A	T/A	1000/A	lbs	%	%	lbs/A
0-0-0	21.5	24.6	2.12	18.0	15.5	4823
80-0-0	32.0	29.5	2.58	18.4	16.0	7459
80-60-0	31.9	30.8	2.46	18.5	16.1	7489
80-0-80	31.0	30.9	2.42	18.6	16.1	7302
80-60-80	32.5	31.8	2.45	18.3	15.9	7521
160-0-0	33.8	32.3	2.37	18.5	16.0	7903
160-0-0 + Fall NPK	34.2	32.6	2.31	18.8	16.3	8151
160-60-0	34.0	32.1	2.36	18.5	16.0	7920
160-0-80	35.9	31.3	2.42	18.4	15.9	8290
160-60-80	34.9	33.1	2.27	18.6	16.0	8145
160-60-80 + 24 S	34.7	31.8	2.50	18.9	16.3	8285
160-60-80 + Fall NPK	35.5	32.7	2.45	18.3	15.8	8166
240-0-0	32.5	31.9	2.33	18.9	16.3	7778
240-60-0	33.5	32.9	2.28	18.7	16.0	7846
240-0-80	34.6	31.2	2.40	18.4	15.9	8034
240-60-80	33.7	32.2	2.29	18.7	16.2	7990
LSD .05	2.3	1.7	0.26	0.5	0.5	568

Fall NPK = 90-90-90 lbs/A applied at planting time.
24S = 24 lbs/A of sulphur
This experiment was conducted in cooperation with W. B. Hallmark and L. P. Brown at the Iberia Research Station.

Table 2. Effect of rate of fertilizer application on the yield of plant cane on a Coteau sil soil on Viator Farm in Lafayette Parish, 1994.

Fertilizer applied $N-P_2O_5-K_2O$	First stubble yield	Stalk		Normal Juice		Sugar yield
		No.	Wt.	Brix	Sucrose	
lbs/A	T/A	1000/A	lbs	%	%	lbs/A
0-0-0	32.0	26.7	2.33	16.6	14.3	6527
80-0-0	31.1	27.1	2.37	16.4	13.9	6165
80-60-0	31.2	26.4	2.48	16.4	14.1	6246
80-0-80	32.1	27.0	2.39	16.3	13.9	6367
80-60-80	34.0	28.6	2.56	16.2	13.8	6652
160-0-0	32.6	27.5	2.44	16.0	13.6	6247
160-60-0	31.6	26.0	2.36	16.4	14.1	6322
160-0-80	33.4	28.0	2.52	16.6	14.2	6743
160-60-80	33.3	26.6	2.46	15.8	13.3	6226
160-60-80 + S[1/]	33.5	29.0	2.42	16.5	13.9	6635
160-60-80 + S + Lime[2/]	30.6	27.4	2.46	16.0	13.7	5935
160-60-80 + S + Lime[3/]	32.8	29.5	2.37	16.9	14.5	6787
240-0-0	30.8	24.5	2.54	16.4	13.9	6087
240-60-0	30.4	25.9	2.33	16.3	13.9	6003
240-0-80	31.2	27.1	2.55	16.6	14.2	6309
240-60-80	32.4	28.4	2.39	16.5	14.0	6457
LSD .05	3.1	3.0	0.31	0.5	0.5	595

[1/]Sulphur at 24 lbs/A rate applied in off-bar furrows.
[2/]Dolomite lime at 1 T/A broadcasted and incorporated before planting.
[3/]Dolomite lime at 1 T/A applied in planting furrows.

This experiment was in cooperation with Dr. W. B. Hallmark and L. P. Brown at the Iberia Research Station.

Table 3. Effect of fall and spring applied fertilizer on the yield of plant cane CP 70-321 planted after a fallow year on Commerce soil on the St. Gabriel Research Station, 1994.

Fertilizer applied $N-P_2O_5-K_2O$		Plant cane - Fallow planted					
		Cane	Stalk		Normal juice		Sugar
Fall	Spring	yield	No.	Wt.	Brix	Sucrose	yield
lbs/A	lbs/A	T/A	1000/A	lbs	%	%	lbs/A
0-0-0	0-0-0	30.6	28.8	2.66	16.4	14.1	6161
	120-0-0	36.0	33.4	2.62	16.9	14.7	7597
	120-0-80	35.5	34.2	2.64	16.9	14.6	7493
	120-40-80	34.9	34.2	2.70	17.0	14.8	7461
15-45-45	120-0-0	35.1	33.9	2.79	17.5	15.3	7754
	120-0-80	37.1	34.5	2.74	17.2	14.9	7997
	120-40-80	36.7	32.9	2.82	17.1	14.8	7813
45-45-45	120-0-0	36.0	31.4	2.41	17.2	15.0	7768
	120-0-80	37.5	32.1	2.61	17.1	14.8	8003
	120-40-80	37.7	32.9	2.64	16.6	14.3	7690
90-90-90	120-0-0	35.9	33.3	2.72	16.9	14.6	7538
	120-0-80	35.4	33.2	2.73	16.5	14.2	7180
	120-40-80	37.7	31.7	2.80	16.7	14.5	7828
LSD .05 Treatments		2.4	1.9	0.23	0.7	0.8	557
		Mean effect					
0-0-0		35.5	33.9	2.66	16.9	14.7	7517
15-45-45		36.3	33.8	2.78	17.2	15.0	7855
45-45-45		37.1	32.1	2.55	17.0	14.7	7820
90-90-90		36.3	32.7	2.75	16.7	14.5	7515
	120-0-0	35.8	33.0	2.63	17.1	14.9	7665
	120-0-80	36.4	33.5	2.68	16.9	14.7	7668
	120-40-80	36.7	32.9	2.74	16.9	14.6	7698
LSD .05 Fall Means		1.4	1.1	0.14	0.4	0.5	336
LSD .05 Spring Means		NS	NS	NS	NS	NS	NS

Table 4. Effect of fall and spring applied fertilizer on the yield of plant cane LCP 85-384 planted in succession on Commerce soil on the St. Gabriel Research Station, 1994.

Fertilizer applied $N-P_2O_5-K_2O$		Plant cane - Succession planted					
		Cane	Stalk		Normal juice		Sugar
Fall	Spring	yield	No.	Wt.	Brix	Sucrose	yield
lbs/A	lbs/A	T/A	1000/A	lbs	%	%	lbs/A
0-0-0	0-0-0	25.5	31.7	1.86	16.5	14.3	5204
	120-0-0	32.4	33.0	2.10	15.9	13.8	6352
	120-0-80	33.7	35.7	2.09	15.4	13.3	6365
	120-40-80 + F	36.4	36.1	1.90	15.4	13.3	6833
15-45-45	0-0-0	28.5	33.2	2.12	16.0	14.0	5689
	120-0-0	37.1	38.2	2.13	16.0	13.9	7354
	120-0-80	33.4	33.9	2.15	15.8	13.7	6478
	120-40-80 + F	41.2	39.2	2.22	15.8	13.8	8045
45-45-45	0-0-0	32.9	34.2	2.07	16.3	14.1	6616
	120-0-0	37.4	37.4	2.29	15.3	13.2	6921
	120-0-80	38.3	40.2	2.22	15.8	13.7	7439
	120-40-80 + F	38.0	37.8	2.16	15.7	13.7	7365
90-90-90	0-0-0	38.2	37.9	2.07	15.4	13.2	7125
	120-0-0	40.2	39.0	2.24	15.8	13.7	7768
	120-0-80	40.6	41.6	2.23	15.2	13.1	7462
	120-40-80 + F	38.9	39.7	1.99	15.3	13.2	7251
LSD .05 Treatments		3.8	4.6	0.31	0.9	1.0	957
		Mean effect					
0-0-0		32.0	34.1	1.99	15.8	13.7	6188
15-45-45		35.1	36.2	2.16	15.9	13.8	6892
45-45-45		36.6	37.4	2.19	15.8	13.7	7085
90-90-90		39.5	39.4	2.13	15.4	13.3	7402
	0-0-0	31.3	34.3	2.03	16.0	13.9	6158
	120-0-0	36.8	36.9	2.19	15.7	13.6	7099
	120-40-80	36.5	37.8	2.17	15.6	13.5	6936
	120-40-80 + F	38.6	38.2	2.07	15.6	13.5	7374
LSD .05 Means		1.9	2.3	0.16	0.5	0.5	479

Table 5. Effect of rate of fall and spring applied fertilizers on yield of first stubble planted after a fallow year on Commerce soil on the St. Gabriel Research Station, 1994.

Fertilizer applied $N-P_2O_5-K_2O$		First Stubble cane - Fallow planted					
		Cane	Stalk		Normal juice		Sugar
Fall	Spring	yield	No.	Wt.	Brix	Sucrose	yield
lbs/A	lbs/A	T/A	1000/A	lbs	%	%	lbs/A
0-0-0	120-0-0	24.4	31.4	2.08	18.5	16.1	5718
	120-40-80	30.6	30.2	1.99	18.4	15.9	7092
45-45-45	120-0-0	33.9	38.8	2.02	18.1	15.6	7708
	120-40-80	36.6	37.4	2.36	18.1	15.6	8318
90-90-90	120-0-0	30.6	28.1	2.40	17.6	15.0	6623
	120-40-80	34.8	31.1	2.21	17.3	14.7	7360
LSD .05 Treatments		2.6	4.9	0.39	0.5	0.6	544
		Mean effect					
0-0-0		27.5	30.8	2.04	18.4	16.0	6405
45-45-45		35.3	38.1	2.19	18.1	15.6	8013
90-90-90		32.7	29.6	2.31	17.5	14.8	6991
	120-0-0	29.6	32.8	2.17	18.1	15.5	6683
	120-40-80	34.0	32.9	2.19	17.9	15.4	7590
LSD .05 Fall Means		1.8	3.5	NS	0.4	0.4	384
LSD .05 Spring Means		1.5	NS	NS	NS	NS	314

Variety LCP 82-089 was planted after a fallow year.
The fall fertilizer was applied in the planting furrows and the spring fertilizer was applied in the off-bar furrows.

Table 6. Effect of rate of fall and spring applied fertilizers on the yield of first stubble LCP 82-089 planted in succession on Commerce soil on the St. Gabriel Research Station, 1994.

Fertilizer applied $N-P_2O_5-K_2O$		First Stubble cane - Succession planted					
		Cane	Stalk		Normal juice		Sugar
Fall	Spring	yield	No.	Wt.	Brix	Sucrose	yield
lbs/A	lbs/A	T/A	1000/A	lbs	%	%	lbs/A
0-0-0	0-0-0	20.9	29.0	1.86	18.3	16.0	4869
	120-0-0	27.9	36.6	2.37	17.9	15.3	6204
	120-40-80	28.9	33.0	1.97	17.5	15.0	6257
	120-40-80 + F	31.1	29.2	2.13	17.9	15.7	7094
45-45-45	0-0-0	18.5	24.3	1.82	17.8	15.4	4111
	120-0-0	29.9	35.0	2.10	17.8	15.5	6707
	120-40-80	33.9	34.1	2.11	18.0	15.7	7729
	120-40-80 + F	36.5	36.7	2.10	18.0	15.6	8250
90-90-90	0-0-0	19.7	21.3	1.47	16.8	14.2	4041
	120-0-0	25.7	24.4	1.86	18.3	15.7	5901
	120-40-80	31.7	37.5	2.24	17.2	14.8	6762
	120-40-80 + F	32.1	33.1	2.23	17.8	15.4	7196
LSD .05 Treatments		3.9	4.8	0.26	0.7	0.8	992
		Mean effect					
0-0-0		27.2	31.9	2.08	17.9	15.5	6099
45-45-45		29.7	32.5	2.03	17.9	15.5	6699
90-90-90		27.3	29.1	1.95	17.5	15.1	5975
	0-0-0	19.7	24.9	1.72	17.6	15.2	4340
	120-0-0	27.8	32.0	2.11	18.0	15.5	6271
	120-40-80	31.5	34.8	2.11	17.6	15.2	6916
	120-40-80 + F	33.2	33.0	2.15	17.9	15.4	7504
LSD .05 Fall Means		2.0	2.4	0.13	0.4	0.4	497
LSD .05 Spring Means		2.3	2.8	0.15	NS	NS	574

F = Furadan

EFFECT OF NITROGEN AND CALCIUM CHLORIDE ON[1] SUGARCANE YIELD PARAMETERS

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SUMMARY

The effects of liquid urea (0, 60, 120, and 180 lbs N/A) and calcium chloride (0, 20, and 40 lbs Ca/A as N-hib Ca supplied by Stoller Chemical Company) were tested on third stubble sugarcane yield parameters.

Unlike in 1992 with first stubble, calcium chloride did not increase cane tonnage or sugar yield in 1994 with third stubble cane. Nitrogen application, however, did progressively increase cane stalk weight, plant population, cane tonnage, and sugar yield up to the 120 lbs N/A rate but had no further effect with 180 lbs N/A.

INTRODUCTION

Sugarcane production in Louisiana is limited by the relatively rapid deterioration in stubble crop yields. This results in the expensive practice of replanting every third or fourth year. Stubble crops also require higher fertilizer rates than plant cane, while producing less cane per acre.

The decrease in cane yields and increased fertilizer needs of stubble crops are thought to be related to the deterioration of the sugarcane root system. Consequently, if cultural practices could be identified that reduce, or delay, the deterioration of sugarcane roots, it should be possible to increase fertilizer use efficiency and yields.

Research with other crops indicates that adding calcium chloride to liquid urea in a soil fertilization program can increase yields. Thus far, however, the effects of calcium chloride have not been determined on sugarcane yields.

Objectives of our study were to:

1) Determine whether calcium chloride can increase sugarcane yields.

2) Determine whether calcium chloride can reduce the N fertilizer requirements of sugarcane.

PROCEDURES

In October of 1990, a urea x calcium chloride soil fertility study was initiated at the

[1] Research was partially supported by Stoller Chemical Company.

Iberia Research Station on a Baldwin silty clay soil. Soil analyses showed P, Na, K, Ca, and Mg values of 279, 36, 281, 3396, and 668 ppm, respectively. Soil pH was 5.2. The experiment consisted of the 12 treatments given in Table 2 replicated three times in a randomized complete block design. Experimental plots consisted of three 5'10"- by 48'- rows, separated by 8'-alleys at the ends of the plots.

In late October of 1990, the sugarcane rows were opened, and variety CP65-357 was planted at three stalks and a lap of two joints. The rows were then closed to allow the sugarcane to germinate.

In early May of 1994, liquid urea and liquid calcium chloride were added to the right off-bar at the N and Ca rates given in Table 2. Phosphorus, K, and S were blanket applied to the left off-bar of all rows in the study at 90 lbs P_2O_5/A (as polyphosphate), 120 lbs K_2O/A (as KCl), and 24 lbs S/A (as gypsum). The rows were "hipped-up" to cover the fertilizer in the off-bar, and the cane was grown till harvest using standard cultural practices.

In September of 1994, sugarcane stalks in all plots were counted to determine the effects of the treatments on plant population. The plots were harvested in November and weighed with a weigh rig. A 10-stalk sample was taken from each plot to determine average stalk weight and juice quality.

RESULTS AND DISCUSSION

Tables 1-4 shows the effect of liquid urea (N) and liquid calcium chloride (Ca) on third stubble yield parameters in 1994. Nitrogen affected ($P \leq 0.10$) stalk weight, plant population, cane yield, and sugar/A (Table 1). Calcium chloride did not affect ($P \leq 0.25$) any of the yield parameters. The N x Ca interactions for the variables were all nonsignificant (Table 1), though there was a trend toward significance ($P \leq 0.25$) for stalk weight (tables 1 and 2).

Table 3 shows that nitrogen fertilization progressively increased stalk weight, plant population, cane yield, and sugar/A up to 120 lbs N/A, but then had no further effect ($P \leq 0.10$) with 180 lbs N/A. Table 4 shows that calcium chloride did not significantly increase any of the measured yield parameters.

Table 1. F-values for yield parameters for a third stubble nitrogen x calcium chloride study on a Baldwin silty clay soil at the Iberia Research Station in 1994.

Source	df	Stalk wt.	Population	CRS	Cane Yield	Sugar Yield
Nitrogen (N)	3	13.58****	4.81*	1.60°	34.48****	33.30****
Calcium (Ca)	2	0.73	0.15	1.02	0.20	0.73
NxCa	6	1.77°	0.53	0.45	0.60	0.61
% CV		9.10	11.37	5.32	10.23	10.61
RMSE		0.1526	2948	10.59	2.511	516.1

$^{\circ}$, *, and **** denote statistical significance at the $P \leq 0.25$, 0.05, and 0.0001 levels, respectively. Remaining F-values were nonsignificant at $P \leq 0.25$.

Table 2. Effect of nitrogen and calcium chloride on third stubble yield parameters at Jeanerette in 1994.

T#	N+	Ca≠	Stalk wt.	Population	CRS	Cane Yield	Sugar Yield
	- lbs/A -		lbs	1000/A	lbs/T	T/A	lbs/A
1	0	0	1.34	22.4	196	17.4	3,410
2	0	20	1.51	23.0	203	17.6	3,580
3	0	40	1.36	24.5	212	17.5	3,690
4	60	0	1.87	25.7	198	25.0	4,920
5	60	20	1.72	24.6	193	22.5	4,310
6	60	40	1.68	25.3	198	23.3	4,620
7	120	0	1.54	25.7	203	26.4	5,340
8	120	20	1.81	28.7	200	28.2	5,640
9	120	40	1.84	26.0	202	29.5	5,990
10	180	0	1.80	29.0	191	29.3	5,580
11	180	20	1.82	28.8	194	28.5	5,550
12	180	40	1.83	27.2	197	29.1	5,730
LSD 0.10			NS	NA	NS	NA	NA
LSD 0.25			0.15	NA	NA	NA	NA

+ Nitrogen was applied as liquid urea.
≠ Calcium was applied as liquid calcium chloride with the liquid urea.
NA Denotes that the LSD values are not given because the NxCa interaction was nonsignificant at $P \leq 0.25$.
NS Denotes that the indicated variables were not affected at the $P \leq 0.25$ level.

Table 3. Effect of nitrogen on third stubble yield parameters at Jeanerette in 1994.

N	Stalk wt.	Population	CRS	Cane Yield	Sugar Yield
lbs/A	lbs	1000/A	lbs/T	T/A	lbs/A
0	1.40	23.3	203	17.5	3,560
60	1.76	25.2	196	23.6	4,610
120	1.73	26.8	202	28.1	5,650
180	1.82	28.3	194	29.0	5,620
LSD 0.10	0.12	2.4	NS	2.0	420
LSD 0.25	NA	1.6	6	1.4	290

NS Denotes that nitrogen fertilization did not affect the yield parameter at the indicated P level.
NA Denotes that the LDS value is not given because the nitrogen x Ca interaction was significant at $P \leq 0.25$.

Table 4. Effect of calcium chloride on third stubble yield parameters at Jeanerette in 1994.

Ca	Stalk wt.	Population	CRS	Cane Yield	Sugar Yield
lbs/A	lbs	1000/A	lbs/T	T/A	lbs/A
0	1.64	25.7	197	24.5	4,810
20	1.71	26.3	197	24.2	4,770
40	1.68	25.8	202	24.9	5,010
LSD 0.10	NS	NS	NS	NS	NS
LSD 0.25	NA	NS	NS	NS	NS

NS Denotes that the variables were not affected by calcium chloride at the indicated P levels.
NA Denotes that the LSD value is not given because the nitrogen x Ca interaction was significant at $P \leq 0.25$.

EFFECT OF UREA SOURCES AND NITROGEN RATES ON SUGARCANE YIELD PARAMETERS

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SUMMARY

A urea and super-urea (which contained a nitrification inhibitor) nitrogen rate study was conducted with plant cane. Results showed that super-urea did not produce significantly ($P \leq 0.10$) more cane or sugar than urea for any of the nitrogen rates used in the study. Highest sugarcane yields were obtained with the 180 lb/A N rate.

INTRODUCTION

Loss of nitrogen from fields during the growing season can result in reduced sugarcane yields. Nitrification inhibitors are sometimes added to urea and ammonium based nitrogen fertilizers to slow the rate at which nitrate is produced. This can result in less nitrogen loss from leaching and denitrification after heavy rainfall, which could result in increased sugarcane yields.

PROCEDURES

In April, 1994, a urea source by nitrogen rate study was initiated with plant cane on a Baldwin silty clay loam soil in St. Mary Parish on CP72-370 plant cane. Initial soil analyses showed 152, 346, 7,148, and 831 ppm, respectively for P, K, Ca, and Mg; soil pH was 7.2. The experiment was replicated seven times in a 7 by 7 Latin square design. Plots consisted of three 5'10"- by 50'- rows with 8'-alleys separating the plots. Fertilizer rates (Table 1) for urea and super-urea (which contained the nitrification inhibitor) were applied with a blanket application of P (60 lbs P_2O_5/A as polyphosphate), K (80 lb/A of K_2O/A as KCl), and S (24 lbs S/A as gypsum) to the inside off-bar of each row in late-April of 1994). The rows were "hipped-up" to cover the fertilizer, and cane was grown to maturity using standard cultural practices.

In September, 1994, the sugarcane stalks in all plots were counted to determine the effect of treatments on plant populations. The plots were harvested in early November and weighed with a weigh rig. A 10 stalk sample was taken from each plot to determine average stalk weight and juice quality.

RESULTS AND DISCUSSION

The effect of the urea sources and nitrogen rates on plant cane yield parameters is given

in Table 1. The fertilizer treatments significantly ($P \leq 0.10$) affected all the yield parameters except CRS. Urea and super-urea progressively increased cane and sugar yields for each incremental increase in nitrogen rate. However, super-urea did not yield significantly ($P \leq 0.10$) higher than urea for any of the nitrogen rates for either cane or sugar.

The 120 lbs N/A rate produced the highest stalk weights for both urea and super-urea. However, both urea sources had their highest plant populations at the 180 lbs N/A rate.

Table 1. Effect of urea sources and rates on plant cane sugarcane yields in 194 in St. Mary Parish.

T#	N-rate	Source	Millable stalk		CRS	Cane Yield	Sugar Yield
			Wt.	No.			
	lbs/A		lbs	1000/A	lbs/T	T/A	lbs/A
1	0	Check	2.08	16.5	194	17.2	3,340
2	60	Urea	2.14	19.2	200	22.5	4,490
3	120	Urea	2.26	20.2	196	26.2	5,120
4	180	Urea	2.23	21.6	195	29.6	5,760
5	60	Super U	2.24	19.4	197	23.7	4,680
6	120	Super U	2.35	20.2	195	27.1	5,290
7	180	Super U	2.25	21.0	194	28.9	5,620
LSD 0.10			0.14	1.0	NS	1.6	350
%CV			7.15	5.48	2.64	6.99	7.82
RMSE			0.1587	1.081	5.166	1.751	382.9

CULTURAL AND LAND MANAGEMENT PRACTICE RESEARCH IN SUGARCANE IN 1994

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SUMMARY

Ten field experiments were conducted in 1994 to test the effects of various cultural and land management practices on the yield components of sugarcane. The newer cane varieties released from the breeding programs at LSU and Houma were included in the experiments. Results from tests on planting practices showed that the average plant cane yields from planting in August, September, and October were similar but higher than planting in November. In first stubble, the October planting date produced the highest yield. Plant cane yields were higher with a four-than a two-stalk rate of planting with some indication that the higher rate is needed more in late rather than in early planting. Covering seedcane with 3-4 or 5-6 inches rather than 7-8 inches of packed soil at planting time produced more plant cane yield.

Harvesting experiments showed that plant cane yields of four varieties increased substantially during October and November due to large increases in stalk weight and percent juice sucrose. These increases were apparently due to the warm weather conditions during the harvest season. First stubble yields were higher when the plant cane was harvested in December than earlier in the season.

In stubble protection experiments, a soil cover applied over cane stubbles immediately after harvesting increased yields of first and second stubble cane. The increases occurred only where the soil cover was not removed by shaving in the spring. In some cases, the shaving of covered plots reduced yield. This shows that a soil cover over stubble for freeze protection can increase yield even during relatively mild winter conditions. In a stubble longevity test, the cane yield in third stubble cane was increased with a NPK starter fertilizer applied at planting time in 1990. A starter fertilizer can apparently produce a strong root system and increase yields in plant and stubble cane crops.

OBJECTIVES

This research is designed to provide information on cultural practices in an effort to help cane growers to produce maximum economic yields and to increase profitability in sugarcane production. This annual progress report is present to provide the latest available data on certain practices and not as a final recommendation for growers to use all of these practices. Recommendations are based on several years of research data.

This research was supported in part by grant funds from the American Sugar Cane League.

RESULTS AND DISCUSSION

Ten field experiments were conducted in 1994 on the St. Gabriel Research Station to test the effects of various cultural and land management practices on the yield and yield components of sugarcane. The new cane varieties released from the breeding programs in the LAES at St. Gabriel and in the USDA at Houma were included in the experiments to determine varietal differences with the various practices.

The winter temperatures in Baton Rouge prior to the 1994 crop were close to normal with 27 days below freezing and only two days below 25°F with a minimum of 22°F. Cane yields in the experiments were above normal apparently due to a good growing season and mild temperatures during the harvest season.

Date and Rate of Planting

An experiment was initiated to test the effects of planting dates on the plant cane yield of four varieties of sugarcane. The dates were August 15, September 1, October 3, and November 1, 1993. The varieties tested were CP 74-383, LCP 82-089, LHo 83-153, and LCP 85-384. Each variety was planted on each date using a 3-stalk planting rate. Also, rates of planting consisting of 2-, 3- and 4- stalks were tested on the September, October, and November planting dates with varieties LCP 82-089 and LCP 85-384.

The data obtained on dates of planting in plant cane in 1994 are reported in Table 1. The results show that the November planting date produced less yield than the September date in CP 74-383 and less yield than all the other dates in LHo 83-153. The yields of LCP 82-089 and LCP 85-384 were not significantly affected by the planting dates. As an average of varieties, the cane and sugar yields from the Aug., Sept., and Oct. dates were similar but higher than the November planting date. The cane growth in the fall after planting was relatively tall from the August planting and decreased progressively with planting dates. All the cane growth died to ground level during the winter. At harvest time, the stalk population decreased and the stalk weight increased progressively with planting dates. The percent brix and sucrose were slightly higher from the early than the late planting dates.

The data obtained on rates and dates of planting in varieties LCP 82-089 and LCP 85-384 are reported in Table 2. The results show as in the above test that the yields of these two varieties were not strongly affected by dates of planting. However, the four-stalk planting rate produced more yield than the two-stalk rate from the November planting in LCP 82-089 and from each planting date in LCP 85-384. The data show some indications that a higher planting rate is needed in a late than an early planting date. As an average of varieties and planting dates, the four-stalk rate produced more than the two-stalk rate.

Other experiments were continued in 1994 from plant cane in 1993 to test the effects of dates of planting and rates of planting on the first stubble yield of different varieties. In the date test, varieties CP 70-321, LCP 82-089, LHo 83-153, and LCP 85-384 were planted on September 1, October 1, and November 10 in 1992. In the rate test, varieties LCP 82-089 and LHo 83-153 were planted using 2-, 3-, and 4-stalk rates on one date in 1992. The data obtained

on dates of planting in first stubble in 1994 are reported in Table 3. The results show that the September and October plantings produced higher yields of first stubble than the November planting in each variety except LHo 83-153. The effect of planting dates on the yield of LHo 83-153 was small. As an average of varieties, the October planting date produced more cane and sugar yields than the other dates. The low yields from the November date were apparently due to poor germination from planting after a mild freeze in 1992. The data obtained on rates of planting in first stubble in 1994 are reported in Table 4. The results show that the cane and sugar yields were similar with the 2- and 4-stalk rates but higher than the 3-stalk rate in each variety. This is unusual in that the 3-stalk rate normally produce more cane yield.

Depth of Seedcane Cover

An experiment was initiated to test the effects of seed cover depth and shaving on the plant cane yield of LHo 83-153 and LCP 82-089. The rows in all plots were furrowed for planting at a normal depth and the cover depths tested were 3-4, 5-6, and 7-8 inches of packed soil. Seedcane of each variety was planted and covered with each soil depth in 1993. A shave and no shave treatment were applied to each cover depth in spring of 1994. The shave treatment left three inches of soil on all the shave plots. The data obtained in plant cane in 1994 are reported in Table 5. The yields were similar with the 3-4 and 5-6 cover depths for each variety but higher than the 7-8 depth in LCP 82-089. As an average of varieties, the cane and sugar yields were less with 7-8 inches of soil cover than the other depths and shaving in spring to remove the excessive soil cover did not improve yield. The differences in yield among treatments were due mostly to differences in stalk population at harvest time.

Date of Harvest

Experiments were conducted in 1994 to test the effects of different harvest dates in plant cane of the newer varieties on the yield of plant cane and the subsequent stubble crop the following year. One test was initiated to measure the effects of harvest dates in plant cane in 1993 and the first stubble in 1994. Varieties CP 70-321, LCP 82-089, LHo 83-153, and LCP 85-384 were harvested on September 1, October 4, November 2, and December 1 in 1993. The effects of the plant cane harvest dates on first stubble yield in 1994 are reported in Table 6. The results show that the December plant cane harvest date produced more first stubble yield than the September date in CP 70-321 and more than the September and November dates in LCP 85-384. As an average of varieties, the December date produced more first stubble sugar yield than the other plant cane harvest dates. This shows that harvesting plant cane late in the season can improve the sugar yield in first stubble cane the following year.

Another test was conducted to measure the effects of harvest dates in plant cane on the yield of plant cane in 1994 and first stubble cane in 1995. Varieties CP 74-383, LCP 82-089, LHo 83-153 and LCP 85-384 were harvested in plant cane on Sept. 1, Oct. 3, Nov. 1, and Dec. 1 in 1994. The yields for the last three harvest dates are reported in Table 7. The results show that large increases in cane and sugar yields occurred in each variety during the harvest season. These increases each month were apparently due to the warm weather conditions during the harvest season. The average sugar yield per acre increased 41.8% during October and 23.6% during November. The largest yield increase was in variety LCP 85-384. This test will be

continued in 1995 to measure the effects of plant cane harvest dates on first stubble cane yield.

Stubble Protection From Freeze Damage

Experiments were conducted in 1994 to test the effects of stubble protection from freeze damage with a soil cover over the cane stubbles during the winter months. One experiment was in first stubble cane to test the effect of stubble soil cover after two harvest dates in plant cane with and without shaving in spring to remove the soil cover. Varieties LCP 82-089 and LHo 83-153 were harvested as plant cane on Oct. 1 and Dec. 1 in 1993 and the cover treatment was applied immediately after each harvest date. The shave treatment was applied in March, 1994. The data obtained in first stubble are reported in Table 8. Results show that the first stubble yields were increased by covering the stubbles after harvesting each variety on each date except for the December harvest date in LHo 83-153. However, the soil cover did not increase yield where it was removed by shaving in the spring. The soil cover without shaving increased the average cane yield 12.0% and sugar yield per acre 11.5%.

Another experiment on stubble protection was conducted in second stubble cane with the same soil cover and shave treatments described in the above test. Varieties CP 70-321 and LCP 82-089 were harvested in plant cane on Oct. 1 and Dec. 1 in 1992 and in first stubble in Nov., 1993. The cover treatment was applied immediately after harvesting the cane each year. The data obtained in second stubble in 1994 are reported in Table 9. Results show that the second stubble yields were increased more by covering the stubbles in LCP 82-089 than in CP 70-321, especially after the December harvest in plant cane. As an average, the removal of the soil cover by shaving in the spring reduced cane yields, stalk population, and sugar yield per acre. A soil cover should be applied immediately after harvesting a crop and not removed by shaving in the spring.

Stubble Cane Longevity Test

An experiment was initiated in plant cane in 1991 and continued through third stubble in 1994 to test the effects of fall applied fertilizers, Furadan, and stubble soil cover on cane yields. Varieties CP 72-370 and CP 74-383 were planted in the test. A 90-90-90 NPK fertilizer was applied in the fall at planting time and a Furadan treatment at 1.5 lbs/A A.I. was applied at planting time and in spring of each crop year. A soil cover treatment over the cane stubbles was applied after harvesting the crop each year. The soil cover was removed in the spring by shaving in first and second stubble but not in third stubble.

The data obtained in third stubble in 1994 show that the yields in CP 72-370 were low and not uniform; therefore, only the yield data in CP 74-383 are reported in Table 10. The results show that the yield for this variety was relatively high and the fall fertilizer applied at planting time increased the cane yield but not the sugar yield per acre. The Furadan and soil cover treatments did not increase the third stubble cane this year.

Table 1. Effect of date of planting on the plant cane yield of four cane varieties on the St. Gabriel Research Station, 1994.

Variety of cane	Date of planting	Plant cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1993	T/A	1000/A	lbs.	%	%	lbs/A
CP 74-383	Aug. 15	35.0	33.4	2.22	15.8	13.6	6758
	Sept. 1	33.9	32.4	2.46	16.8	14.6	7114
	Oct. 3	37.8	35.6	2.33	16.5	14.3	7756
	Nov. 1	30.6	31.8	2.31	15.9	13.7	5976
LCP 82-089	Aug. 15	33.9	40.8	1.89	17.9	15.7	7726
	Sept. 1	34.6	39.6	2.17	17.8	15.6	7855
	Oct. 3	30.9	36.2	2.29	17.1	14.9	6605
	Nov. 1	32.4	32.4	2.57	17.3	15.1	7035
LHo 83-153	Aug. 15	38.4	41.8	2.04	17.9	15.9	8867
	Sept. 1	37.7	37.8	2.42	17.9	15.6	8559
	Oct. 3	40.1	41.0	2.20	17.2	15.2	8854
	Nov. 1	34.2	36.8	2.21	17.6	15.3	7566
LCP 85-384	Aug. 15	38.0	45.7	1.86	17.4	15.2	8348
	Sept. 1	38.1	42.8	2.03	17.6	15.5	8602
	Oct. 3	37.8	38.8	2.14	16.7	14.7	7990
	Nov. 1	35.7	35.5	2.24	16.5	14.5	7434
LSD .05 Treatments		3.3	3.5	0.33	0.8	0.9	882
		Mean date effect					
	Aug. 15	36.3	40.4	2.00	17.2	15.1	7925
	Sept. 1	36.1	38.2	2.27	17.5	15.3	8032
	Oct. 3	36.7	37.9	2.24	16.9	14.8	7801
	Nov. 1	33.3	34.1	2.33	16.8	14.7	7003
LSD .05 Means		1.7	1.8	0.17	0.4	0.4	442

Planted with a 3-stalk rate on each date.

Table 2. Effect of date and rate of planting on the plant cane yield of two cane varieties on the St. Gabriel Research Station, 1994.

Variety of cane	Date of planting	Rate of planting	Plant cane yield	Stalk		Normal juice sucrose	Sugar yield
				No.	Wt.		
	1993	Stalks	T/A	1000/A	lbs	%	lbs/A
LCP 82-089	Sept. 1	2	33.1	36.6	2.19	14.9	7107
		3	34.6	39.6	2.17	15.6	7855
		4	33.5	40.0	1.94	15.5	7549
	Oct. 3	2	33.0	32.9	2.39	14.9	7068
		3	30.9	36.2	2.29	14.9	6605
		4	33.5	39.5	2.15	15.2	7364
	Nov. 1	2	30.6	30.1	2.54	15.0	6641
		3	32.4	32.4	2.57	15.1	7035
		4	33.9	34.7	2.61	15.1	7386
LCP 85-384	Sept. 1	2	34.7	39.3	2.17	15.1	7580
		3	38.1	42.8	2.03	15.5	8602
		4	38.9	44.5	1.85	16.0	9076
	Oct. 3	2	34.6	33.6	2.12	14.8	7374
		3	37.8	38.8	2.14	14.7	7990
		4	39.4	43.7	2.06	15.4	8829
	Nov. 1	2	36.0	34.2	1.94	14.8	7639
		3	35.7	35.5	2.24	14.5	7434
		4	39.2	39.4	1.99	14.3	8031
LSD .05 Treatments			3.3	4.6	0.33	0.8	776
			Mean effect				
	Sept. 1		35.5	40.5	2.06	15.4	7961
	Oct. 3		34.9	37.5	2.19	15.0	7538
	Nov. 1		34.6	34.4	2.31	14.8	7361
		2	33.7	34.4	2.23	14.9	7235
		3	34.9	37.6	2.24	15.0	7587
		4	36.4	40.3	2.10	15.3	8039
LSD .05 Means			1.3	1.9	0.14	0.3	318

Table 3. Effect of date of planting on the first stubble cane yield of four varieties of sugarcane on Commerce soil on the St. Gabriel Research Station, 1994.

Variety of cane	Date of planting	First stubble yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1992	T/A	1000/A	lbs	%	%	lbs/A
CP 70-321	Sept. 1	28.9	34.1	2.37	17.9	15.7	6606
	Oct. 1	34.6	35.5	2.13	18.1	15.9	8003
	Nov. 10	18.2	23.8	2.12	17.4	15.3	4033
LCP 82-089	Sept. 1	31.8	37.6	2.18	18.2	15.7	7263
	Oct. 1	34.4	37.4	2.16	18.3	15.6	7824
	Nov. 10	28.6	28.9	2.25	18.3	15.8	6600
LHo 83-153	Sept. 1	32.3	40.0	1.98	18.5	16.1	7579
	Oct. 1	34.4	44.5	1.73	18.4	16.0	8048
	Nov. 10	32.7	42.2	1.87	18.6	16.2	7763
LCP 85-384	Sept. 1	38.6	50.2	1.75	18.4	16.1	9083
	Oct. 1	37.6	43.7	1.97	18.5	16.3	8954
	Nov. 10	33.1	47.1	1.68	18.2	16.0	7700
LSD .05 Treatments		3.0	5.4	0.26	0.5	0.5	775
		Mean planting date effect					
	Sept. 1	32.9	40.5	2.07	18.3	15.9	7633
	Oct. 1	35.3	40.3	2.00	18.3	16.0	8207
	Nov. 10	28.2	35.5	1.98	18.2	15.8	6524
LSD .05 Means		1.5	2.7	NS	NS	NS	388

Table 4. Effect of rate of planting on first stubble yield of two varieties of sugarcane on Commerce soil on the St. Gabriel Research Station, 1994.

Variety of cane	Rate of planting	First stubble yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	Stalks	T/A	1000/A	lbs	%	%	lbs/A
LCP 82-089	2	35.7	33.7	2.16	17.8	15.2	7838
	3	31.4	36.7	2.08	18.1	15.5	7069
	4	33.9	37.7	2.11	17.8	15.6	7660
LHo 83-153	2	38.7	43.9	1.99	17.5	15.1	8413
	3	36.1	41.7	1.93	17.3	14.8	7708
	4	39.3	40.5	2.26	17.4	15.1	8542
LSD .05 Treatments		1.8	4.6	0.21	1.0	1.1	725
		Mean rate effect					
	2	37.2	41.3	2.08	17.7	15.1	8125
	3	33.8	39.2	2.00	17.7	15.2	7388
	4	36.6	39.1	2.18	17.6	15.3	8101
LSD .05 Means		1.3	NS	0.15	NS	NS	512

Table 5. Effect of depth of seed cover and shaving on the plant cane yield of two varieties of sugarcane on a Commerce soil on the St. Gabriel Research Station, 1994.

Seed cover depth	Shave treat.	Plant cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
inches		T/A	1000/A	lbs.	%	%	lbs/A
				LCP 82-089			
3-4	Check	33.4	35.6	2.33	17.2	14.8	7089
	Shave	30.0	32.5	2.56	17.2	14.8	6380
5-6	Check	32.9	32.4	2.37	16.9	14.6	6871
	Shave	29.4	30.0	2.10	16.5	14.2	5982
7-8	Check	29.0	30.3	2.40	16.8	14.5	6058
	Shave	27.2	29.4	2.34	17.0	14.6	5716
				LHo 83-153			
3-4	Check	35.5	35.3	2.03	17.5	15.2	7779
	Shave	32.2	32.9	2.19	17.5	15.1	7013
5-6	Check	35.7	33.1	2.62	17.2	15.1	7766
	Shave	32.8	31.8	2.26	17.4	15.1	7184
7-8	Check	33.2	33.4	2.39	17.4	15.1	7263
	Shave	31.2	31.8	2.29	17.4	15.1	6797
LSD .05 Treatments		2.8	2.9	0.30	0.5	0.5	658
				Mean Effect			
3-4		32.8	34.1	2.28	17.3	15.0	7065
5-6		32.7	31.8	2.34	17.0	14.8	6951
7-8		30.2	31.2	2.36	17.1	14.8	6459
	Check	33.3	33.4	2.36	17.2	14.9	7138
	Shave	30.5	31.4	2.29	17.2	14.8	6512
LSD .05 Depth Means		1.4	1.5	NS	0.2	NS	330
LSD .05 Shave Means		1.2	1.2	NS	NS	NS	269

Table 6. Effect of date of harvesting plant cane on yield of the subsequent stubble cane of four varieties on Commerce soil on the St. Gabriel Research Station, 1994.

Variety of cane	Date of plant cane harvest	First stubble yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1993	T/A	1000/A	lbs.	%	%	lbs/A
CP 70-321	Sept. 1	36.6	40.8	2.13	17.9	15.8	8423
	Oct. 4	36.3	33.3	2.26	17.0	14.8	7732
	Nov. 2	36.1	34.9	2.39	16.9	14.9	7771
	Dec. 1	38.6	38.2	2.37	17.5	15.3	8541
LCP 82-089	Sept. 1	35.8	47.7	1.97	18.3	15.8	8245
	Oct. 4	37.7	45.3	2.04	18.0	15.6	8566
	Nov. 2	38.6	40.4	2.37	18.3	16.0	8978
	Dec. 1	39.1	41.5	2.24	18.0	15.5	8772
LHo 83-153	Sept. 1	37.1	49.2	1.74	18.7	16.1	8691
	Oct. 4	39.4	46.7	1.92	18.1	15.8	9092
	Nov. 2	38.2	48.4	1.69	18.5	16.2	9062
	Dec. 1	39.9	48.3	1.92	18.5	16.1	9363
LCP 85-384	Sept. 1	42.8	48.7	1.79	18.6	16.5	10305
	Oct. 4	43.5	55.5	1.91	18.3	16.2	10304
	Nov. 2	42.7	53.8	1.59	18.2	16.1	10028
	Dec. 1	45.9	54.0	1.85	18.1	16.0	10699
LSD .05 Treatments		3.0	4.8	0.26	0.4	0.5	654
		Mean date effect					
	Sept. 1	38.1	46.6	1.91	18.4	16.0	8916
	Oct. 4	39.2	45.2	2.03	17.9	15.6	8923
	Nov. 2	38.9	44.4	2.01	18.0	15.8	8959
	Dec. 1	40.9	45.5	2.09	18.0	15.7	9344
LSD .05 Means		1.5	NS	0.13	0.2	0.3	327

Table 7. Effect of date of harvest on the yield of four varieties of plant cane on Commerce soil on the St. Gabriel Research Station, 1994.

Variety of cane	Date of plant cane harvest	Plant cane yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
	1994	T/A	1000/A	lbs.	%	%	lbs/A
CP 74-383	Oct. 3	24.9	34.7	2.03	16.8	14.2	5063
	Nov. 1	32.6	37.4	2.06	18.3	15.8	7448
	Dec. 1	43.5	42.9	2.30	16.4	14.1	8717
LCP 82-089	Oct. 3	30.8	43.8	1.92	17.4	14.6	6408
	Nov. 1	40.0	45.5	2.13	18.3	15.4	8930
	Dec. 1	43.4	49.3	1.98	18.1	15.6	9843
LHo 83-153	Oct. 3	27.3	39.0	1.80	17.8	15.1	5950
	Nov. 1	33.8	42.4	1.95	19.3	16.8	8318
	Dec. 1	48.6	46.6	2.24	17.9	15.6	10967
LCP 85-384	Oct. 3	30.1	42.3	1.95	17.4	14.8	6370
	Nov. 1	37.6	44.6	2.09	18.8	16.5	9045
	Dec. 1	54.2	56.5	2.15	17.7	15.5	12171
LSD .05 Treatments		6.6	4.6	0.37	0.9	1.1	1591
		Mean date effect					
	Oct. 3	28.3	38.8	1.88	17.3	14.7	5948
	Nov. 1	36.0	41.2	2.07	18.6	16.1	8435
	Dec. 1	47.4	48.7	2.14	17.5	15.2	10424
LSD .05 Means		3.3	2.3	0.19	0.5	0.5	796

The plant cane of each variety was harvested on four dates and the yields were measured on the last three dates in 1994.

Table 8. Effect of stubble protection on the first stubble yield of two cane varieties on the St. Gabriel Research Station, 1994.

Date of plant cane harvest	Stubble protection treatment	First stubble yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
1993	1993	T/A	1000/A	lbs.	%	%	lbs/A
				LCP 82-089			
Oct. 1	Check	31.8	33.7	2.22	17.1	14.4	6538
	Cover-shave	32.0	33.1	2.01	16.9	14.5	6675
	Cover	36.6	37.2	2.42	17.4	14.7	7762
Dec. 1	Check	36.9	37.5	2.24	17.4	14.9	7931
	Cover-shave	36.0	38.9	2.29	17.1	14.5	7508
	Cover	42.4	39.2	2.50	17.1	14.6	8904
				LHo 83-153			
Oct. 1	Check	30.8	35.3	1.86	16.5	14.0	6165
	Cover-shave	30.2	38.2	1.76	17.1	14.6	6348
	Cover	34.4	39.1	1.95	17.3	14.7	7294
Dec. 1	Check	36.8	41.3	2.07	17.9	15.6	8365
	Cover-shave	33.9	41.0	1.88	17.8	15.4	7582
	Cover	39.2	40.2	2.12	17.2	14.8	8366
LSD .05 Treatments		2.6	2.8	0.23	0.6	0.7	800
				Mean effect			
	Check	34.1	37.0	2.10	17.2	14.7	7250
	Cover-shave	33.0	37.8	1.98	17.2	14.8	7028
	Cover	38.2	38.9	2.25	17.2	14.7	8081
LSD .05 Means		1.3	1.4	0.11	NS	NS	401

The soil cover was applied on the cane stubbles immediately after each harvest date. Cover-shave plots were covered and shaved in spring to remove cover.

Table 9. Effect of stubble protection on the second stubble yield of two cane varieties on the St. Gabriel Research Station, 1994.

Date of plant cane harvest	Stubble protection treatment	Second stubble yield	Stalk		Normal juice		Sugar yield
			No.	Wt.	Brix	Sucrose	
1992	1993	T/A	1000/A	lbs.	%	%	lbs/A
				CP 70-321			
Oct. 1	Check	22.8	26.4	2.27	16.9	14.7	4822
	Cover-shave	18.5	20.7	1.84	15.7	13.4	3493
	Cover	21.2	23.3	1.97	16.4	14.3	4317
Dec. 1	Check	28.8	31.2	2.18	16.8	14.7	6083
	Cover-shave	25.6	31.3	2.29	16.4	14.1	5159
	Cover	26.6	31.3	1.96	16.9	14.6	5575
				LCP 82-089			
Oct. 1	Check	30.9	36.1	2.01	16.7	14.2	6243
	Cover-shave	26.2	33.7	1.49	16.4	13.9	5181
	Cover	33.0	38.6	1.94	16.5	13.9	6521
Dec. 1	Check	30.4	37.4	1.78	16.9	14.5	6330
	Cover-shave	28.6	33.3	2.10	17.1	14.7	6032
	Cover	36.1	39.3	1.93	17.5	15.1	7866
LSD .05 Treatments		2.3	2.8	0.28	0.6	0.7	535
				Mean effect			
	Check	28.2	32.8	2.06	16.8	14.5	5869
	Cover-shave	24.7	29.8	1.93	16.4	14.0	4966
	Cover	29.2	33.1	1.95	16.8	14.5	6069
LSD .05 Means		1.1	1.4	NS	0.3	0.3	268

The soil cover was applied immediately after each harvest date in plant cane and one harvest date in first stubble. Cover-shave plots were shaved to remove cover each spring.

Table 10. Effect of fall applied fertilizer, Furadan and soil cover on third stubble yield of CP 74-383 on the St. Gabriel Research Station, 1994.

Fall Fertilizer $N-P_2O_5-K_2O$	Furadan	Soil Cover	Third Stubble Yield	Stalk		Normal juice sucrose	Sugar yield
				No.	Wt.		
lbs/A			T/A	1000/A	lbs	%	lbs/A
0-0-0	Check	Check	29.8	33.4	2.16	13.6	5714
		Cover	30.1	28.0	2.00	13.7	5844
	Furadan	Check	27.1	30.8	2.18	13.2	5048
		Cover	27.8	28.1	1.80	12.4	4781
90-90-90	Check	Check	32.7	29.8	1.88	12.9	5930
		Cover	31.0	29.4	1.95	12.8	5537
	Furadan	Check	28.9	33.9	2.02	12.6	5116
		Cover	29.3	34.1	1.81	13.2	5430
LSD .05 Treatments			1.8	2.8	0.24	1.1	824
			Mean effect				
0-0-0			28.7	30.1	2.04	13.2	5347
90-90-90			30.5	31.8	1.92	12.9	5503
	Check		30.9	30.1	2.00	13.2	5756
	Furadan		28.3	31.7	1.95	12.9	5094
		Check	29.6	32.0	2.06	13.1	5452
		Cover	29.5	29.9	1.89	13.0	5398
LSD .05 Means			0.9	1.4	0.11	NS	413

The fall fertilizer was applied at planting time, Furadan at planting and each spring and soil cover after harvesting each year in the crop cycle.

FATE OF APPLIED CHEMICALS AS AFFECTED BY MANAGEMENT PRACTICES FOR SUGARCANE

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SUMMARY

The primary objective of this study was to evaluate the effectiveness of sugarcane pesticide management practices on movement of atrazine, metribuzin, and azinphosmethyl in surface runoff and subsurface flow from sugarcane fields in south Louisiana. These data are necessary to quantify water quality benefits and effectiveness of best management practices (BMPs) on reducing nonpoint source pollutants from herbicide and insecticide applications. Three types of chemical applications were carried out: a full broadcast (high treatment), a 36-inch band application (conventional or standard treatment), and a 24-inch band application (low treatment). The standard treatment received the recommended fertilizer amounts 120-40-80 lb/acre as N-P_2O_5-K_2O, whereas the high treatment received 180-80-120 and the low treatment received 60-0-0 lb/acre. Cumulative amounts of chemical loss in runoff waters were highest for full broadcast (high treatment) and lowest for the 24-inch band treatment. These data have an important implication of BMP of agricultural chemicals for sugarcane.

PROBLEM STATEMENT

Minimizing the levels of agricultural chemicals present in surface and ground water is of major concern nationally and within the agricultural community. Central to the issue of agricultural chemical management is their potential contamination of surface and subsurface waters. A primary purpose of the Clean Water Act (Section 319) and the Coastal Zone Management Act (section 6217) is to evaluate, demonstrate, and implement best management practices (BMPs) to improve the water quality in the 12 drainage basins of Louisiana (Louisiana Department of Environmental Quality (LDEQ), 1990). Because applied agricultural chemicals are potential contributors to nonpoint source pollution, it is essential to quantify each commodity's input to the problem and evaluate BMPs that have the potential of improved water quality in surface waters.

An evaluation of nonpoint source pollution (NPS) of Louisiana was published in 1985 by the Association of State and Interstate Water Pollution Control Administration. It was found that 76% of the rivers, 56% of the lakes, and 76% of the estuaries were impaired to some degree. The major NPSs include urban runoff, resource extraction, agriculture, silviculture, and hydromodification. Under section 319 of the Clean water Act the 12 water basins in Louisiana were extensively evaluated. Details of each basin can be found in the NPS Pollution Assessment Report (LDEQ, 1990), and water quality parameters can be found in the Water Quality Inventory documented of Cormier et al. (1990).

OBJECTIVES

Little work has been carried out on correlating application of fertilizers, herbicides, and insecticides that are used in sugarcane with water quality impairment. Moreover, the NPS Assessment Report indicated that most water bodies in Louisiana are impaired to some degree. Therefore, the purpose of this study was to quantify the fate of applied chemicals in the soils in southern Louisiana and to more specifically:

- Compare the concentration levels of fertilizers (N, P, K) and commonly used herbicides and insecticides in runoff water under the standard or conventionally accepted cultural sugarcane practices and BMPs in southern Louisiana.

- Obtain quantifiable surface and ground water data on the types of nonpoint source pollutants present in surface runoff and ground water when several management practices are utilized.

METHODS

Since the primary purpose of this study was to evaluate the effectiveness of the recommended management practices in reducing nonpoint source pollutants from sugarcane fields, the BMPs selected to compare conventional practices with practices recommended through the Soil Conservation Service (USDA-SCS) and the Louisiana Cooperative Extension Service included: (i) integrated pest management, (ii) nutrient management, and (iii) cover crops. To evaluate the effectiveness of these BMPs in minimizing NPS contamination potential, the treatments chosen in this demonstration project were such that different amounts and/or methods of applications of fertilizers and pesticides were implemented.

This sugarcane water quality study was initiated in 1992 and consists of three treatments and two replications. The duration of the study is four years; three growing seasons (plant cane, first and second stubble) and one fallow year. The site chosen is at St. Gabriel Station of the Louisiana State University Agricultural Center. The experimental site is approximately 3.5 acres, and the soil was classified as a commerce silt loam (Aeric Fluvaquent, fine-silty, mixed, nonacid, thermic). The land was rowed and prepared for six-foot rows where six plots (2 replications x three treatments) running east to west were outlined with levees on each side of each treatment. Sugarcane variety CP 70-321, which is a major variety for southern Louisiana, was chosen and planting was completed in September 1992.

At the lowest part (north-east corner) of each plot, we installed sumps (corrugated, galvanized culverts, 36-inches in diameter and 6 1/2-feet in depth). A plate (sheet metal 1/16-inch thick) was welded at the bottom of each sump. A hole was dug and was subsequently back filled following installation of the sumps, and the remaining soil was used to close the levees surrounding each plot. Additional earth moving was carried out in order to insure that each plot was completely leveed and that runoff water was collected into each sump through a V-type opening. In each sump, water pumps connected to a flow meter were also installed. As a result, the only outlet for surface runoff water was through the pump and flow meter and exiting into the levees between plots. Adjacent to each sump, we placed an ISCO water sampler and

connected the sampler tubing and sensors to each sump by placing the sampler cup and sensor at the bottom of each sump. Sample collection was triggered when runoff water was detected by a float in the water pump.

To optimize the benefit from this work, we chose the amounts and/or number of applications of applied agricultural chemicals to be above and below that which is recommended for use as the accepted cultural practice for sugarcane in southern Louisiana. Briefly, the differences among our three treatments- conventional or standard treatment, high treatment, and low treatment- are as follows:

Fertilizers: The standard or conventional treatment received the recommended amounts of N-P-K of 120-40-80 lb/acre as N-P_2O_5-K_2O, whereas the high treatment received 180-80-120 and the low treatment received 60-0-0 lb/acre. Fertilizer application was banded each spring for all treatments.

Herbicides: Metribuzin was applied as a pre-emergence herbicide and atrazine as a winter application for weed control following harvest. Both metribuzin and atrazine were applied as a broadcast for the high treatment, banded with 36-inch band-width for the standard treatment, and banded with 24-inch band-width for the low treatment. We maintained the intensity of herbicide application (amount per area of coverage) constant for all three treatments. As a result, for the 36-inch band-width applications, one-half the amount of herbicides received on an acre basis compared to the broadcast application. For the 24-inch band-width (treatment 3), only 1/3 of herbicides will be applied. Actual amounts applied for atrazine were 2, 1, and 0.66 quarts/acre and for metribuzin were 1.8, 0.9, and 0.6 lb/acre for the high, standard, and low treatments, respectively. In addition, asulox was applied as a broadcast in late spring or early summer as a post-emergence herbicide.

Insecticides: The insecticide azinphosmethyl is commonly used in southern Louisiana during June-August. The number of broadcast applications of azinphosmethyl (1.5 quarts/acre) during the summer is dependent on the extent of sugarcane borers. In this study, the number of applications varied from a single application for the low treatment to three applications for the high treatment. The timing of application was chosen to be mid-July, mid-August, and mid-September. The mid-August application was received by all treatments.

Winter cover: After the third year, following cane harvest of second stubble, one treatment will remain fallow until planted with soybeans in the spring of the fourth year. In another treatment, the plots will remain fallow until next fall when they will be planted with a new sugarcane crop. In the third treatment, the plots will planted to winter wheat after harvest in October or early November.

RESULTS

Comprehensive data sets of atrazine and metribuzin concentrations in the runoff water and that extractable from the soil surface have been obtained. These data sets illustrate clearly the concentration levels of these pesticides in surface water and in the soil following application in winter and spring 1994. For the high treatment (broadcast application), atrazine concentration

levels in the runoff ranged from 600-700 ppb (parts per billion) measured 6 days following applications. For the standard (conventional), treatment, only half the total area of the field received atrazine. As a result the concentration level was drastically reduced to a range of 120 - 140 ppb. Some three months following applications, the amount detected in the surface water was in the 20-30 ppb range. For the low treatment, although the amount applied was 0.6 lb/acre versus 2 lb/acre for the high treatment, the amount in surface waters was an order of magnitude lower in comparison to the high treatment. Based on these results, the total amounts of atrazine loss in runoff water were 0.22, 0.08, and 0.05 lb/acre for the high, standard, and low treatments, respectively.

During the 1994 season, some two weeks of no rainfall followed our March 18, 1994 metribuzin application. Metribuzin concentrations in runoff waters after March 27 and April 4 rainfalls (0.6 and 1.0 inches, respectively) were negligible. These conditions are believed to be responsible for the low concentrations of metribuzin subsequently observed in runoff water. Moreover, metribuzin is highly soluble in comparison with atrazine with low retention capacity (Kd or Koc) by the soil matrix and is highly susceptible to downward movement in the soil profile. Significant concentrations were observed in runoff waters following rainfall events of April 12 and 15. The concentration of metribuzin following these events ranged from 10 to 20 ppb with a measured maximum of 68.2 ppb. Results with time also show that after June 1 data, the levels of concentrations decreased rapidly some two months following metribuzin applications to levels below 1 ppb. Results of extractable atrazine and metribuzin in the soil surface also decreased rapidly with time. Maximum concentration occurred 2 - 3 days following application for all three treatments. Lowest concentrations in the soil were observed for the low treatment whereas maximum concentrations were observed for the high treatment. It is important to emphasize here that metribuzin results are consistent with that of 1993 results (not shown). Moreover, similar patterns were observed for azinphosmethyl and applied fertilizer nutrients. For example from Janauary to June, 1994, amounts of N loss in the runoff were 16.8, 14.8, and 10.1 lb/acre, for the high, standard, and low treatments, respectively. For phosphorus as P_2O_5, the corresponding losses were 10.1, 10.2, and 10 lb/acre.

Harvest: Cane harvest was carried out on November 9, 1994. Counts of the number of stalks per acre were performed prior to harvest. In addition, subsamples were taken for complete sugar analysis. The table below provides the results for all three treatments: standard, high, and low treatment. One parameter that shows significant differences among treatments was sugarcane yield (tons per acre), with the standard treatment yielding higher than the low treatment. Another parameter that shows significant differences among treatments was sugar yield (pounds per acre), with the standard and high treatments yielding higher than the low treatment. We conclude based on these results that the standard treatment provided highest yields with optimum fertilizer utilization and lowest pesticides amounts needed. The standard application used in this study reflects the recommended cultural practice for sugarcane in south Louisiana.

TECHNOLOGY TRANSFER

The above results on pesticides clearly illustrate the importance of method of application or placement of applied agricultural chemicals. These data have an important implication on

best management practices (BMP) of agricultural chemicals by sugarcane farmers in southern Louisiana.

REFERENCES

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Table 1. Effect of applied chemicals of the low, standard and high treatments on the first stubble cane yield of CP 70-321 on Commerce silt loam soil on the St. Gabriel Research Station, 1994.

TREATMENT	Rep. Number	Plot Number	Number of Stalks per acre	Cane Yield tons/ acre	Total solids (BRIX) %	Suc. %	Sugar Yield lbs/ acre
Low	1	3	26,900	28.2	17.0	15.4	6283
	2	5	24,900	30.8	16.6	15.0	6656
	Average		25,900	29.5	16.8	15.2	6470
Standard	1	1	24,000	30.8	17.1	15.3	6793
	2	6	28,100	32.3	16.8	15.0	6982
	Average		26,100	31.6	16.8	15.1	6887
High	1	2	23,000	30.8	16.7	15.0	6645
	2	1	29,100	31.9	16.8	15.1	6976
	Average		26,100	31.4	16.8	15.0	6810
	LSD .05		NS	2.0	NS	NS	293

EVALUATION OF CONSERVATION CROPPING SEQUENCES WITH SUGARCANE

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SUMMARY

An evaluation of practices designed to conserve soil and protect water sources from pesticide and fertilizer contamination was initiated in the summer of 1993. Fallow-period comparisons were: a conventional fallow utilizing only tillage; a fallow period utilizing herbicides and no tillage; and green manure soybeans. Additionally, post-planting comparisons superimposed on the fallow-period treatments were off-barring vs. no off-barring and winter legume vs. no winter legume. Plant cane yields were significantly lower only for cane planted in decomposing soybean residue. Allelopathic effects of soybean residue on plant cane stands were quite discernible in the fall after planting. Additionally, weed infestations in plant cane were substantially higher for plots planted to soybeans during the fallow period. There was no difference in yield between plots that were off-barred and those that were not off-barred.

INTRODUCTION

Sugarcane culture does not readily lend itself to tillage and cover crop systems designed to reduce soil erosion. Unfortunately, numerous sugarcane fields in the state possess the soil type and topography conducive to significant soil loss from erosion. Soil removed from such sites may carry unacceptable levels of pesticides and fertilizer, which serve to contaminate water supplies. Approaches to control or minimize soil loss include reducing tillage and/or enhancing ground cover during the fallow period and the growing cycle. Most conservation tillage systems require a minimum of 30% ground cover after planting. Sugarcane culture is in compliance for most of the growing season but may benefit from reduced tillage or the presence of cover crops at certain times and under certain conditions.

EXPERIMENTAL PROCEDURES

A field experiment was initiated in the summer of 1993 on a Baldwin silty clay loam with an average organic matter content of 1.92 %.

Three fallow-period treatments followed by sugarcane were compared. A conventionally tilled fallow, a fallow utilizing only glyphosate and no tillage, and green manure soybeans without tillage or herbicides were the fallow-period treatments. Plot size was three rows, each 50 ft in length. Precipitation amounts were excessive in June and July, 1993, preventing expeditious tillage of conventional fallow plots. Two passes with row-choppers were accomplished in the conventional fallow plots, one in late May and then not again until the third week of July. On the glyphosate-only plots, glyphosate was applied in mid-July at the rate 2 qt/acre mixed with .25% non-ionic surfactant. Pioneer brand 9592 (maturity group V) soybean

Research was supported by the American Sugar Cane League

was planted on May 18, 1993, by using two drills spaced 20 in apart on conventional sugarcane rows. A preemergence application of 2 pt of Dual and 2/3 lb of Lexone per acre was used only for the soybean plots. Soybeans were shredded and incorporated in the row on September 7.

All rows in the experimental area were capped-off and rebuilt and LCP 85-89 was planted on September 9. A preemergence application of Lexone was sprayed on a 30 in band at the rate of 1 lb/acre.

"Serena" burr medic clover was drilled on the shoulder of rows in all plots planted to soybeans and to half of the glyphosate plots on October 7, 1993. The clover was seeded at 30 lb/a using appropriate inoculum. Weedmaster, at the rate of 1 qt per acre, was sprayed on February 20, 1994 to desiccate the clover.

On March 8, 1994 the superimposition of the off-barring treatment was accomplished on half of all plots. All plots received recommended rates of fertilizer and herbicides.

Sugarcane was harvested and weighed on November 12, 1994 using a tractor-mounted weigh rig. A randomized complete-block design was used to evaluate treatment response. Analyses of variance were conducted for the variables cane and sugar yields and their components.

Table 1. Description of eight conservation tillage treatments.

Type of fallow	Herbicides	Off-barring	Winter legume
Conventional	None	Yes	No
Conventional	None	No	No
Chemical	Glyphosate	Yes	No
Chemical	Glyphosate	No	No
Soybean	None	Yes	Yes
Soybean	None	No	Yes
Chemical	None	Yes	Yes
Chemical	None	No	Yes

RESULTS

Within a month of the planting of sugarcane following the completion of the various fallow-period treatments, a weakness in the stand of cane following the incorporated soybean residue was noted. Stands of cane following the other fallow-period treatments appeared normal. As shown in figure no. 1, the observed stand weakness of the fall carried over to the following growing season, when it was manifested as both lower millable stalk number and sugar yield. Both millable stalk number and sugar per acre yield were significantly lower for sugarcane following the soybean fallow treatments. It is conjectured that decomposing soybean residue inhibited germination of planted cane. Allelopathic effects of cover crop residues on plant stands has been well documented for other commodities.

Fig. no. 2 depicts the sugar yield of cane planted after the conventional fallow, chemical

fallow, soybean fallow, and winter legumes (winter legumes were superimposed over chemical and soybean fallow plots).

Omitting off-barring in the spring (fig. no. 3) did not significantly influence sugar yield of plant cane.

An evaluation of weed prevalence was made in July, 1994. Fig. no. 4 shows a subjective rating for weeds (bermudagrass, nutsedge, morningglory, signalgrass, and johnson grass). The rating revealed markedly higher infestations in cane plots planted after soybeans. Bermudagrass was particularly conspicuous in these plots. The presence of soybeans during the fallow period can be viewed as an opportunity to control grass with over-the-top herbicides. However, it was apparent in this study that failure to do so can exacerbate weed infestations occurring later in the cane cycle.

Fig. 1- Association of Stalk Number and Sugar Yield for the Eight Conservation Tillage Treatments

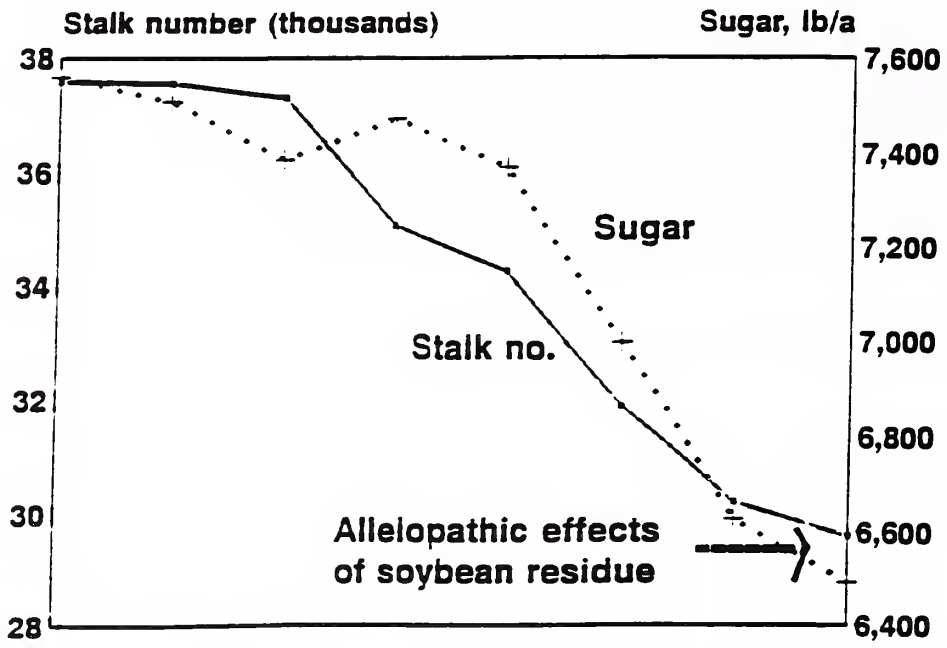


Fig. 2 - Sugar yield of cane following the conservation tillage treatments

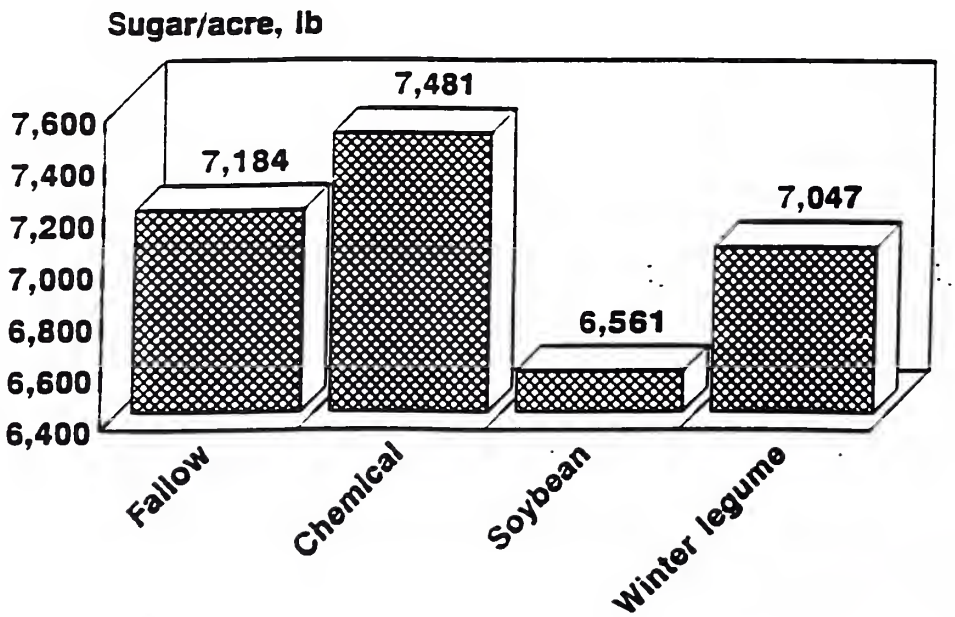


Fig. 3 - Influence of off-barring on sugar yield.

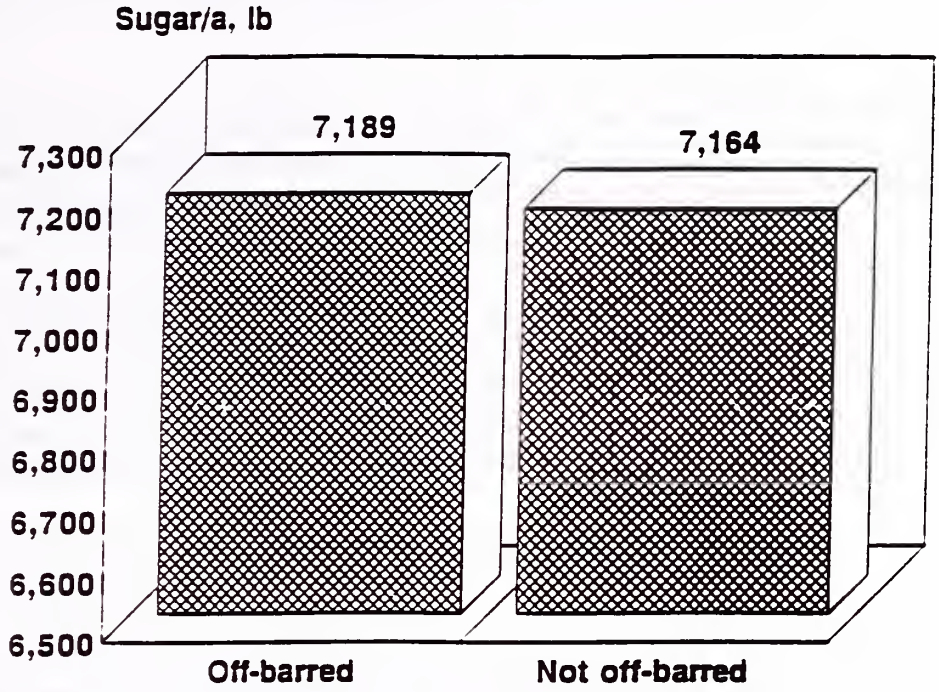
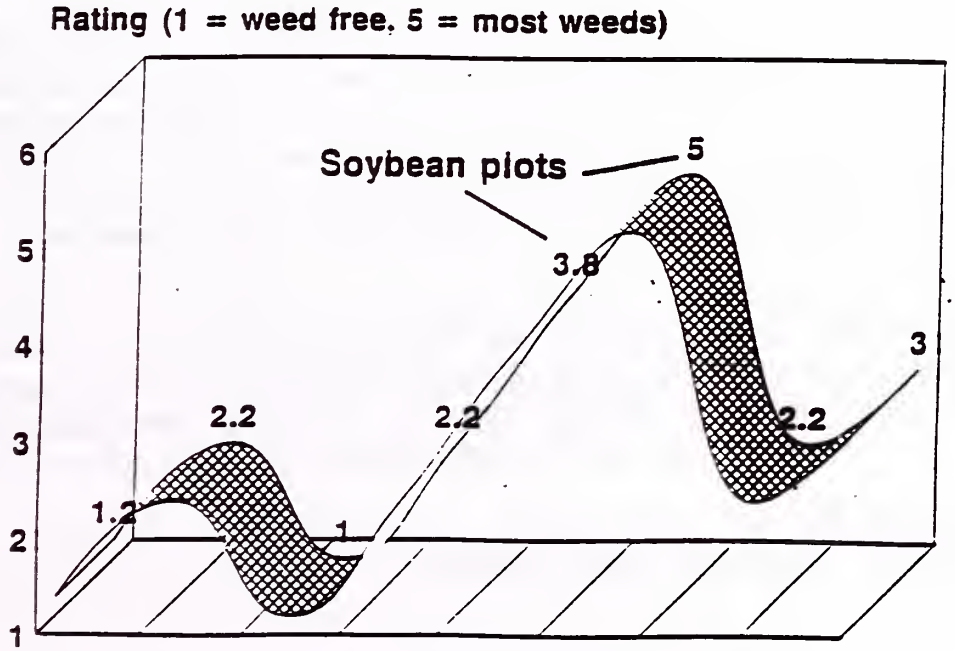


Fig. 4 - Weed population for eight conservation tillage treatments



STUBBLE RESPONSE TO FALLOW-YEAR SOYBEANS

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Iberia Research Station

SUMMARY

An experiment was conducted on a silt loam to determine sugarcane response to incorporated soybean residue and/or applied N fertilizer. First stubble sugarcane plots following soybean residue incorporated in the fallow period did not yield greater than sugarcane following a conventional fallow period (7,101 vs. 7,057 lb of sugar/acre). In the previous plant cane year, lower cane yield cropped after soybeans was thought to be associated with the presence of parasitic nematodes. However, parasitic nematode numbers were even higher in first stubble, without a corresponding reduction in sugar or stalk yield. Possible explanations for lower plant cane yield following fallow-period soybeans include: heightened sensitivity to nematodes by plant cane, harmful influence of decomposing soybean residue, or an artifact (substance or condition not normally present). Furadan, applied in the spring, did not affect nematode population or cane yield.

INTRODUCTION

Crop sequences involving legumes as either a cash crop or a green manure crop in rotation with commodities are widely used in parts of the U.S. Inclusion of a legume improves soil physical properties and increases soil N availability. Little is known of the N response of sugarcane cropped after soybeans. The amount of N mineralized from soybean residues for uptake by sugarcane has not been measured in our environment. The objective of this study was to compare soybean residues and fallow as sources of N for sugarcane nutrition on a relatively low organic matter soil.

EXPERIMENTAL PROCEDURES

The experiment was conducted on a Jeanerette silt loam low in P and K, with a relatively low organic matter content of 1.1%. Treatments were a conventional fallow and sugarcane rotation grown with 0 and 130 lb N per acre applied to plant cane and soybeans rotated with sugarcane with 0 and 130 lb N per acre applied to plant cane. Soybean cultivar Riverside 499 (Group IV maturity) and sugarcane variety CP 70-321 were planted on May 5 and October 5, 1992. The experimental design was a randomized complete block with three replications.

To determine the amounts of nitrate and exchangeable ammonium in soil profiles, duplicate soil samples for each plot were taken to a depth of 5 ft, 4 ft, and 1 ft, respectively, in April, 1992, February, 1993 and August, 1993. Soil was not analyzed for nitrogen content in first stubble plots. Cores were in 6 in increments for the first 1-ft, and 1 ft increments for the remaining depths. Composite soil samples from each depth increment were prepared by

Research was supported by the American Sugar Cane League

thoroughly mixing soil from the duplicate cores from each plot. Soil was dried at 30 to 35 degrees C in a forced-air drier and ground to pass a 1-mm screen. The amount of exchangeable NH_4^+-N was determined by extraction of soil with 2M KCL (1:10 soil:KCL) using a Wescan Ammonia Analyzer (Alltech Associates, Deerfield, IL). The concentrations of NO_3^--N in the KCL extracts were determined using the Wescan instrument fitted with a Zn reduction column.

Phosphorus and potassium fertilization and preemergence weed control were accomplished in a conventional manner according to recommended practices. Nitrogen fertilizer (32% liquid N formulation) was applied to certain plant cane plots on April 1, 1993, in accordance with experimental design. All first stubble plots received the same application of a 160-40-80 NPK fertilizer.

At harvest six stalks, with tops and leaves intact, were randomly selected from each plot to determine total N concentration in whole-plant tissue. Samples were dried at 30 to 35 degrees C in a forced-air drier, ground to pass a 1-mm screen, and analyzed by micro-Kjeldahl. Nitrogen uptake in individual treatments was calculated from the N concentrations found in the whole-plant samples and the corresponding dry matter for millable stalks and tops and leaves.

Soil samples were intermittently collected each growing season for nematode evaluation. Plant and non-plant parasitic nematodes were counted per 100 ml of soil. Multiple samples were taken for each plot and replicate counts were determined for each sample.

Plot size for the fallow treatments and plant cane were eight rows, 200 ft long and 68 in wide. In an attempt to determine the influence of parasitic nematodes on cane production, Furadan (1 gal of 4F formulation per acre) was applied to half of each plot in early March, 1994. Consequently, harvest plot size for the determination of first stubble yields was four rows, 50 ft long and 68 in wide.

RESULTS

Statistical analysis of first stubble yield and quality data revealed no significant influence of fallow-year treatments on first stubble cane and sugar yields. First stubble yield following the conventional fallow period and green manure soybeans was 7,101 and 7,057 lb of sugar/acre, respectively.

Similar to the plant cane year, the parasitic nematode population was significantly higher in first stubble plots following soybeans (1,916 vs 1,249 parasitic nematodes/lb of soil). However, unlike the plant cane year, the presence of nematodes did not appear to depress yield (Fig. no. 1), in spite of even higher populations than were present in the plant cane year. The cause and effect association postulated last year for the influence of nematodes on sugarcane yield obviously does not apply to the first stubble crop. Either plant cane is more susceptible than stubble cane to nematode damage, or the depressed plant cane yields were erroneously attributed to the presence of nematodes.

Furadan, applied in the spring at greenup time, did not statistically lower nematode count. Also, the application of Furadan did not affect yield of cane or sugar (Fig. no. 2).

Fig. 1 - Relationship of Nematode Population and Sugar Yield

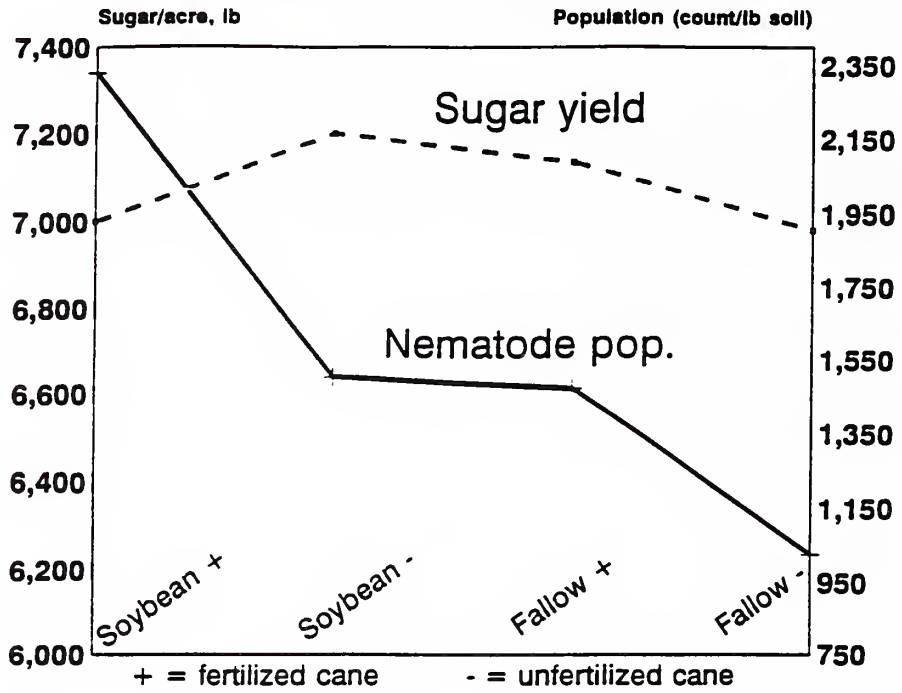
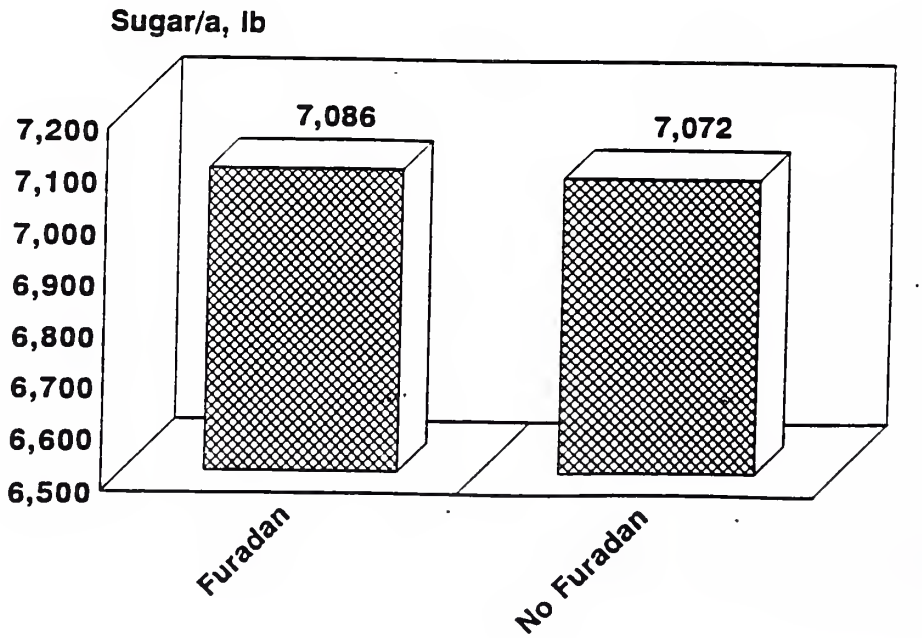


Fig. 2 - Influence of Furadan on sugar yield.



EFFECT OF COMPOSTED MUNICIPAL WASTE AND SUGARMILL WASTE ON[1] SUGARCANE YIELD PARAMETERS

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SUMMARY

A nitrogen x waste product study was conducted on first stubble cane in 1994 on a Jeanerette silt loam soil. Nitrogen rates consisted of 0 and 150 lbs/A. Waste product treatments were composed of: 1) boiler ash (20 T/A); filter press mud (17 T/A); liquid fish (24 gallons/A); bagasse (15 T/A) and liquid sewage (3.6 T/A); and composted municipal waste (40 T/A).

Where no nitrogen was used, filter press mud, liquid fish, and compost all increased ($P \leq 0.10$) cane tonnage (5.4, 5.0, and 10.3 T/A, respectively) and sugar yield (1,330; 1,130; and 2,270 lbs/A). Where the full rate of nitrogen fertilizer was used, only bagasse + sewage, and compost significantly increased both cane tonnage (3.3 and 4.1 T/A, respectively) and sugar yield (640 and 960 lbs/A). These results indicate that compost and sugarmill wastes may have a place in sugarcane production in Louisiana.

INTRODUCTION

Municipalities and sugarmills face a growing problem of disposing of their solid waste. A possible solution to this problem is to use these waste materials in sugarcane production.

Objectives of our study were to:

1) Determine the effect of composted municipal waste and sugarmill waste on sugarcane yield parameters.
2) Determine the effect of compost on chemical composition of soil and sugarcane plants.
3) Determine whether compost and sugarmill waste can be economically used to replace or supplement commercial fertilizer in the growing of sugarcane.
4) Determine whether using compost and sugarmill waste can prolong the sugarcane cycle by producing respectable third stubble yields.

PROCEDURES

In August, 1992 a sugarcane fertilizer x waste product study was initiated on a Jeanerette

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[1] Compost and mill wastes were supplied by the Bedminster Bioconversion Corporation and Sterling Sugar, respectively.

silt loam soil in St. Mary Parish. The experimental design was a randomized split-plot with four replications. Soil analyses for the check plots showed P, Na, K, Ca, and Mg values of 40, 32, 112, 2,320, and 391 ppm, respectively. Soil pH was 6.2. Fertilizer rates served as main plots and waste products comprised the split plots (Tables 1 and 2). All experimental plots received 80 and 120 lbs, P_2O_5 and K_20/A as a blanket application in April of 1994. The high fertilizer rate main plot received 150 lbs N/A as UAN in April 1994. The six sub-plots consisted of: 1) a check; 2) boiler ash applied to opened rows on August 18, 1992 at 20 T/A; 3) filter press mud applied on August 19, 1992 at 17 T/A; 4) liquid fish applied at 24 gallons/A in early May, 1994 in the off-bar; 5) bagasse applied on August 19, 1992 at 15 T/A in opened rows; and 6) 40 T/A of composted municipal waste applied on September 5, 1992 on top of planted cane in opened rows. After the boiler ash, filter press mud, and bagasse were applied to opened rows in August of 1992, the rows were closed until the cane was planted in early September with Kleentek LCP 82-89 at two stalks and a lap of two joints. In mid-May, 1993 lime treated sewage sludge (3.6 T/A, 60 lbs N/A) was applied to treatments 5 and 11.

All experimental plots consisted of three 5'10"- by 48'- rows with 8'- alleys separating the plots. The experimental plots were grown till maturity in November, 1994 when they were harvested.

RESULTS AND DISCUSSION

Nitrogen application had a significant ($P \leq 0.10$) effect on stalk weight, plant population, cane tonnage, and sugar yield (Table 1). Compost and waste materials affected populations, and cane and sugar yields. There were also nitrogen x waste interactions for cane yield ($P \leq 0.10$), and CRS and sugar yield ($P \leq 0.25$).

Table 2 shows that nitrogen significantly ($P \leq 0.10$) increased cane tonnage for all six waste treatments (T# 7-12 vs. T# 1-6). Nitrogen increased sugarcane tonnage 17.9 T/A where waste products were not used (T# 7 vs. T# 1) and 11.7 T/A where 40 T/A of compost had been added at planting (T# 12 vs. T# 6). Nitrogen application also increased sugar yields appreciably for all the treatments (T# 7-12 vs. T# 1-6). However, there was a trend ($P \leq 0.25$) toward lower CRS where nitrogen was added to the filter press mud treatment (T# 9 vs. T# 3).

In the absence of nitrogen fertilizer, filter press mud, liquid fish, and compost all increased ($P \leq 0.10$) cane tonnage and sugar yields (Table 2, T# 3,4, and 6 vs. T# 1). Compost increased cane yields by 10.3 T/A (T# 6 vs. T# 1), which indicates that it had a considerable amount of fertilizer value. Bagasse + sewage sludge also increased sugar yields by 650 lbs/A (T# 5 vs. T# 1).

Where nitrogen fertilizer was used, only bagasse + sewage and compost significantly ($P \leq 0.10$) increased both cane tonnage and sugar yield (Table 2, T# 11 and 12 vs. T# 7). Compost increased tonnage by 4.1 T/A and sugar by 960 lbs/A. Filter press mud also increased cane tonnage, but not sugar. Boiler ash and liquid fish did not affect ($P \leq 0.25$) either cane tonnage or sugar yield (T# 8 and 10 vs. T# 7).

Table 3 shows that nitrogen appreciably increased stalk weights and plant populations,

which explains the effect of nitrogen on cane yields (tables 2 and 3).

Table 4 shows the main effects of the compost and waste treatments on the measured yield parameters. Compost and filter press mud significantly increased plant population.

Table 1. F-values for effect of nitrogen fertilizer, compost, and sugarmill wastes on first stubble yield parameters on a Jeanerette silt loam soil at Franklin in 1994.

Source	df	Stalk wt.	Population	CRS	Cane yield	Sugar yield
Nitrogen (N)	1	17.91*	123.01**	0.34	596.16***	1489.17****
Compost and waste materials (W)	5	0.74	4.71**	0.95	7.46***	6.75***
N x W	5	0.98	1.29	1.72°	2.10■	1.91°
%CV for N		21.64	9.27	5.55	7.65	5.01
%CV for W		10.38	6.84	2.66	9.62	9.69
RMSE for N		0.4126	2524	13.31	2.085	326.0
RMSE for W		0.1978	1861	6.388	2.260	630.8

°, ■, *, **, ***, and **** denote statistical significance at the $P \leq 0.25$, 0.10, 0.05, 0.01, 0.001, and 0.0001 levels, respectively. Remaining F-values were not significant at $P \leq 0.25$.

Table 2. Effect of nitrogen fertilizer, compost, and sugarmill wastes on first stubble yield parameters on a Jeanerette silt loam soil at Franklin in 1994.

T#	N	Waste	Millable stalk Wt.	Millable stalk No.	CRS	Cane yield	Sugar yield
	lbs/A		lbs	1000/A	lbs/T	T/A	lbs/A
1	0	None	1.60	21.3	245	15.9	3890
2	0	boiler ash	1.62	21.1	238	16.7	3990
3	0	filter press mud	1.70	24.2	245	21.3	5220
4	0	liquid fish	1.65	23.4	241	20.9	5020
5	0	bagasse + sewage	1.51	22.8	241	18.8	4540
6	0	compost	1.87	26.7	236	26.2	6160
7	150	None	2.28	30.5	241	33.8	8150
8	150	boiler ash	2.17	31.1	238	34.8	8270
9	150	filter press mud	2.16	32.8	230	37.1	8500
10	150	liquid fish	2.12	31.2	241	33.9	8150
11	150	bagasse + sewage	2.21	33.0	238	37.1	8790
12	150	compost	2.22	32.8	241	37.9	9110
LSD 0.10 for N			NA	NA	NS	3.6	530
LSD 0.25 for N			NA	NA	12	1.8	270
LSD 0.10 for W			NS	NA	NS	3.3	560
LSD 0.25 for W			NS	NA	5	2.1	520

NS Denotes that the treatment means were not different at the indicated P levels.
NA Denotes that LSD values are not given because the N x W interaction was not significant at $P \leq 0.25$.

Table 3. Effect of nitrogen fertilizer on first stubble yield parameters on a Jeanerette silt loam soil at Franklin in 1994.

Nitrogen	Millable stalk Wt.	Millable stalk No.	CRS	Cane yield	Sugar yield
lbs N/A	lbs	1000/A	lbs/T	T/A	lbs/A
0	1.66	23.3	241	20.0	4800
150	2.19	31.8	238	35.6	8460
LSD 0.10	0.10	0.9	NS	NA	NS
LSD 0.25	0.07	0.7	NA	NA	NA

NS Denotes that nitrogen did not affect the indicated yield parameter at the designated P level.
NA Denotes that the LSD value is not given because the compost x fertilizer interaction was statistically significant at the $P \leq 0.25$ level.

Table 4. Effect of compost and sugarmill waste on first stubble yield parameters on a Jeanerette silt loam soil at Franklin in 1994.

Waste	Millable stalk Wt.	Millable stalk No.	CRS	Cane Yield	Sugar Yield
	lbs	1000/A	lbs/T	T/A	lbs/A
None	1.94	25.9	243	24.8	6020
Boiler ash	1.89	26.1	238	25.8	6130
Filter press mud	1.90	27.9	239	28.1	6630
Liquid fish	1.88	27.3	241	27.4	6590
Bagasse + sewage	1.74	26.2	240	24.9	5950
Compost	2.04	29.8	238	32.0	7630
LSD 0.10	NS	1.6	NS	2.3	NA
LSD 0.25	NS	1.2	NA	1.6	400

NS Denotes that the treatment means were not significantly different at the indicated P levels.
NA Denotes that the LSD value is not given because the compost x fertilizer interaction was statistically significant at the $P \leq 0.25$ level.

EFFECT OF COMPOSTED MUNICIPAL WASTE ON SUGARCANE PRODUCTION AND FERTILIZER REQUIREMENTS

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X. Wan, L.P. Brown, and G.L. Hawkins
Iberia Research Station, Agronomy Department,
and Audubon Sugar Institute

SUMMARY

Semi-banding 10 T/A of compost under cane at planting in 1990 to a Baldwin silty clay soil did not increase ($P \leq 0.10$) cane tonnage in 1994 with third stubble cane. There was, however, a trend ($P \leq 0.25$) toward higher sugar yields (560 lbs sugar/A) with the 10 T/A compost application, but only where the full recommended rate of fertilizer was used. Applying 1 T/A of compost in the off-bar with commercial fertilizer did not affect any of the yield parameters measured in the study. Application of commercial fertilizer appreciably increased stalk weight, plant population, and cane and sugar yield.

In a second study, incorporating up to 100 T/A of compost in a Baldwin silty clay soil prior to planting increased second stubble cane tonnage (8.8 T/A) and sugar yields (1,710 lbs/A) where commercial fertilizer was not used. However, highest sugar yields were obtained where 20 T/A of compost and the full recommended rate of fertilizer were used together.

INTRODUCTION

Municipalities face a growing problem of safely disposing of their sewage sludge and garbage. At present, due to concerns for the environment, many landfills are closed or are being closed. The landfill in Iberia Parish was terminated and solid waste is now trucked out of the parish at considerable cost. Surrounding parishes face similar problems. A possible solution to this situation is to make compost from sewage sludge and solid waste. The compost could then be used for agricultural purposes.

One approach to making compost is that used by the Bedminster Bioconversion Corporation. The "Bedminster Process" combines sewage sludge with solid waste in a "three-day turning drum process". This results in a compost that is free of harmful organisms. Research is needed to determine whether this material can be safely and profitably used in growing sugarcane.

Objectives of our study were to:

1) Determine the effect of compost on sugarcane yields.

Research was supported by the Bedminster Bioconversion Corporation, the American Sugar Cane League, Iberia Parish Council, the City of New Iberia, Iberia Sugar Cooperative, Cajun Sugar Cooperative, Jeanerette Sugar Company, and M.A. Patout and Sons.

2) Determine whether compost can be economically used to replace or supplement commercial fertilizer in the growing of sugarcane.

3) Determine the effect of compost on the chemical composition of soil and sugarcane plants.

PROCEDURES

In October, 1990 a fertilizer by compost study was initiated at the Iberia Research Station on a Baldwin silty clay soil. The experiment consisted of the twelve treatments given in Table 2, replicated three times in a randomized complete block design. Experimental plots consisted of three 5'10"- by 48'- rows, separated by 8'- alleys at the ends of the plots.

All plots received either 0, 5, or 10 tons/A of compost (Table 2) applied to opened rows in early October, 1990 and the rows were closed until planting. In late October the rows were re-opened and Kleentek variety CP65-357 was planted at three stalks and a lap of two joints. The rows were then closed to allow the sugarcane to germinate.

In March, 1994 the sugarcane rows were off-barred to allow the soil to warm up. In mid-April, the fertilizer and compost rates indicated in Table 2 were applied to the left off-bar of each row; the rows were "hipped-up" to cover the compost and fertilizer in the off-bar; and the cane was grown to maturity using standard cultural practices.

Two additional compost by fertilizer experiments were initiated in the fall of 1991. The first was grown on a Baldwin silty clay soil at the Iberia Research Station at Jeanerette (tables 3-6), where compost was applied in early October and spread across rows from furrow-to-furrow at 0, 20, 40, 60, 80, and 100 T/A (dry weight basis) and disked into the rows twice. The rows were then opened and planted in mid-October to Kleentek variety CP70-321 at three stalks and a lap of two joints.

The second test was grown on a Memphis silt loam soil at Youngsville in cooperation with Mr. Wilson Viator (tables 7-10). In this study, compost was applied at 0, 15, 30, 45, 60, and 75 T/A on top of the rows in early September 1991 and disked into the rows twice. The rows were opened in mid-September and planted with first progeny Kleentek variety CP70-321 at three stalks and a lap of two joints.

Both the Jeanerette and Youngsville tests used a randomized complete block design with three replications. Plots consisted of five 5'10"- by 48'- rows with 8'- alleys at the ends of the plots and a border row separating the plots. Fertilizer was applied to the right off-bar of all rows receiving fertilizer in April of 1994 at 160 lbs N, 90 lbs P_2O_5, 120 lbs K_2O, and 24 lbs S/A. The rows were "hipped-up" to cover the fertilizer, and cane was grown to maturity using standard cultural practices.

In September of 1994, sugarcane stalks were counted to determine the effects of the treatments on plant population. The plots were then harvested (the three center rows) in November and December and weighed with a weigh rig. A 10- stalk sample was taken from

each plot to determine average stalk weight and juice quality.

RESULTS AND DISCUSSION

Compost and fertilizer treatments affected ($P \leq 0.10$) third-stubble stalk weights, plant population, cane yield, and sugar yield at Jeanerette in 1994 (Table 1). Fertilizer rates increased cane tonnage within all three of the compost rates applied in 1990 (Table 2). Fertilizer increased cane yield 16.9 T/A where no compost was applied in 1990; 16.2 T/A where compost was added at 5 T/A; and 16.5 T/A where 10 T/A of compost was applied. The increase in cane tonnage with fertilizer application was, apparently, caused by the effect of fertilizer on plant population and stalk weight (Table 2). Adding 5 and 10 T/A of compost before planting in 1990 did not increase ($P \leq 0.10$) cane tonnage in 1994.

As with cane tonnage, fertilizer application increased ($P \leq 0.10$) sugar/A (Table 2) at all three compost rates (0, 5, and 10 T/A). However, the increase in sugar yield with the 1.0x fertilizer rate was greater (3360 vs. 3090 lbs/A) where compost was added at 10 T/A versus where it was not added. This shows the synergistic effect of compost and fertilizer on sugar yield.

Adding 10 T/A of compost in 1990 did not increase sugar/A in 1994 at the $P \leq 0.10$ level. However, there was a trend ($P \leq 0.25$) toward higher yields with compost application where the full rate of fertilizer was used (T#12 vs. T#4).

Adding 1 T/A of compost in the off-bar with fertilizer in 1994 did not significantly ($P \leq 0.10$) increase stalk weight, plant population, CRS, cane tonnage, or sugar/A.

The effects of compost and fertilizer on second stubble yield parameters at Jeanerette in 1994 are given in tables 3-6. Fertilizer affected ($P \leq 0.10$) stalk weight, population, CRS, cane yield, and sugar yield, while compost affected stalk weight and cane and sugar yield. There were fertilizer x compost interactions for CRS and cane and sugar yield.

Table 4 shows that fertilizer increased ($P \leq 0.10$) CRS where 0 and 80 T/A of compost was added in 1991 before planting. Fertilizer also increased cane and sugar yields for the 0, 20, 40, 60, and 80 T/A compost rates, but not for the 100 T/A rate.

Higher sugar yield responses with fertilizer application in the absence of compost (2760 lbs/A) versus where 100 T/A of compost was added (450 lbs/A) indicate that the high compost rates were supplying on appreciable amount of nutrients.

Compost significantly ($P \leq 0.10$) increased both cane tonnage and sugar yields where fertilizer was not added. This, again, indicates that the compost had fertilizer value.

The effects of fertilizer and compost on sugarcane yield variables in 1994 at Youngsville are given in tables 7-10. Fertilizer affected only cane tonnage, while compost did not significantly ($P \leq 0.10$) affect any of the yield parameters (Table 7). There was, however, a fertilizer x compost interaction for sugar yield (tables 7 and 8).

Failure to obtain appreciable yield responses to fertilizer application at Youngsville (tables 8 and 9) with second stubble cane on the light textured soil indicates that the test may have been inadvertently fertilized in 1994 by the cooperating producer.

Table 1. F-values for effect of fertilizer and compost addition on third stubble sugarcane yield parameters for a Baldwin silty clay soil at the Iberia Research Station in 1994.

Source	df	Stalk wt.	Population	CRS	Cane Yield	Sugar Yield
Treatments	11	4.54**	12.89**	1.12	23.32****	23.30****
% CV		12.07	7.75	5.55	9.30	9.63
RMSE		0.1787	2198	10.50	2.375	465.6

** and **** denote statistical significance at the $P \leq 0.01$, and 0.0001 levels, respectively. Remaining F-value was not significant at $P \leq 0.25$.

Table 2. Effect of fertilizer and compost on third stubble yield parameters at Jeanerette in 1994.

T#	1990+ Compost	Fert.≠	1994§ Compost	Millable stalk Wt.	Millable stalk No.	CRS	Cane yield	Sugar yield
	T/A		T/A	lbs	1000/A	lbs/T	T/A	lbs/A
1	0	0	0	1.20	19.9	184	14.1	2,570
2	0	0.5x	0	1.55	31.3	191	27.4	5,240
3	0	0.5x	1.0	1.59	29.9	178	27.4	4,880
4	0	1.0x	0	1.64	30.9	183	31.0	5,660
5	5	0	0	1.18	23.6	191	15.4	2,940
6	5	0.5x	0	1.57	30.1	200	29.3	5,860
7	5	0.5x	1.0	1.48	28.8	193	27.0	5,220
8	5	1.0x	0	1.61	31.4	189	31.6	5,980
9	10	0	0	1.05	19.9	190	15.3	2,860
10	10	0.5x	0	1.69	29.9	196	28.6	5,610
11	10	0.5x	1.0	1.47	32.0	182	27.6	5,020
12	10	1.0x	0	1.73	32.7	195	31.8	6,220
LSD 0.10				0.25	3.1	NS	3.3	650
LSD 0.25				0.17	2.1	NS	2.3	450

+ Compost rates were based on dry weight.

≠ The 1.0x fertilizer rate consisted of 160 lbs N, 90 lbs P_2O_5, 120 lbs K_2O, and 24 lbs S/A.

NS Denotes that the treatment means were not different at the indicated P levels.

§ Compost was applied in April of 1994 in the off-bar along with the fertilizer.

Table 3. F-values for effect of fertilizer and compost addition on second stubble yield parameters for a Baldwin silty clay soil at the Iberia Research Station in 1994.

Source	df	Stalk wt.	Population	CRS	Cane yield	Sugar yield
Fert. (F)	1	7.81*	12.75**	21.84****	61.51****	93.99****
Compost (C)	5	2.57■	0.91	0.64	2.42■	2.61■
FXC	5	0.34	0.24	3.42*	3.98*	6.08**
% CV		10.43	6.41	4.34	7.76	8.30
RMSE		0.2105	2079	8.401	2.622	545.5

■,*,**, and **** denote statistical significance at the P≤0.10, 0.05, 0.01, and 0.0001 levels, respectively. Remaining F-values were not significant at P≤0.25.

Table 4. Effect of fertilizer and compost on second stubble yield parameters at Jeanerette in 1994.

T#	Compost+	Fert.+	Millable Stalk		CRS	Cane yield	Sugar yield
			Wt.	No.			
	T/A		lbs	1000/A	lbs/T	T/A	lbs/A
1	0	0	1.76	29.8	187	25.4	4,750
2	0	1.0x	2.05	32.9	197	38.2	7,510
3	20	0	1.76	31.4	175	27.0	4,700
4	20	1.0x	1.97	34.2	211	37.8	8,000
5	40	0	1.89	30.0	190	29.7	5,640
6	40	1.0x	2.20	33.3	198	37.0	7,320
7	60	0	1.95	31.1	195	31.9	6,210
8	60	1.0x	1.99	33.7	197	35.5	7,000
9	80	0	2.16	32.6	189	33.9	6,390
10	80	1.0x	2.34	34.4	207	38.6	7,980
11	100	0	1.99	32.2	189	34.2	6,460
12	100	1.0x	2.14	33.4	192	36.1	6,910
LSD 0.10			NA	NA	12	3.7	760
LSD 0.25			NA	NA	8	2.5	520

+ Compost rates were based on dry weight.

+ The 1.0x fertilizer rate consisted of 160 lbs N, 90 lbs P_2O_5, 120 lbs K_2O, and 24 lbs S/A.

NA Denotes that the LSD value is not given because the compost x fertilizer interaction was not significant at the P≤0.25 level.

NS Denotes that the treatment means were not different at the indicated P levels.

Table 5. Effect of fertilizer on second stubble yield parameters at Jeanerette in 1994.

Fert.	Millable stalk Wt.	Millable stalk No.	CRS	Cane yield	Sugar yield
	lbs	1000/A	lbs/T	T/A	lbs/A
0	1.92	31.2	187	30.3	5,690
1.0x	2.12	33.6	200	37.2	7,450
LSD 0.10	0.12	1.2	NA	NA	NA
LSD 0.25	0.08	0.8	NA	NA	NA

NA Denotes that the LSD value is not given because the compost x fertilizer interaction was statistically significant at the $P \leq 0.25$ level.

Table 6. Effect of compost on second stubble yield parameters at Jeanerette in 1994.

Compost	Millable stalk Wt.	Millable stalk No.	CRS	Cane yield	Sugar yield
T/A	lbs	1000/A	lbs/T	T/A	lbs/A
0	1.91	31.3	192	31.8	6,130
20	1.86	32.8	193	32.4	6,350
40	2.05	31.6	194	3.3	6,480
60	1.97	32.4	196	33.7	6,610
80	2.25	33.5	198	36.2	7,190
100	2.07	32.8	190	35.2	6,690
LSD 0.10	0.21	NS	NA	NA	NA
LSD 0.25	0.14	NS	NA	NA	NA

NS Denotes that compost did not affect the yield parameters at the indicated P levels.
NA Denotes that the LSD is not given because the compost x fertilizer interaction was significant at the $P \leq 0.25$ level.

Table 7. F-values for effect of fertilizer and compost addition on second stubble yield parameters for a Memphis silt loam soil at Youngsville in 1994.

Source	df	Stalk wt.	CRS	Cane yield	Sugar Yield
Fert. (F)	1	0.50	1.64°	5.39*	2.67°
Compost (C)	5	0.73	0.50	0.55	0.85
FXC	5	1.17	0.37	1.97°	2.92*
% CV		7.12	4.12	6.89	6.38
RMSE		0.1512	8.018	2.354	423.7

°, and * Denote statistical significance at the $P \leq 0.25$ and 0.05 levels, respectively.

Table 8. Effect of fertilizer and compost on second stubble yield parameters at Youngsville in 1994.

T#	Compost+	Fert.≠	Stalk wt.	CRS	Cane yield	Sugar yield
	T/A		lbs	lbs/T	T/A	lbs/A
1	0	0	2.03	191	32.6	6,240
2	0	1.0x	2.07	191	35.0	6,690
3	15	0	2.14	202	32.5	6,560
4	15	1.0x	2.13	192	34.7	6,650
5	30	0	2.05	196	33.0	6,460
6	30	1.0x	2.30	196	36.2	7,106
7	45	0	2.08	199	32.8	6,530
8	45	1.0x	2.13	194	36.4	7,050
9	60	0	2.27	196	36.9	7,210
10	60	1.0x	2.11	190	33.3	6,301
11	75	0	2.06	194	31.6	6,150
12	75	1.0x	2.12	194	34.8	6,740
LSD 0.10			NA	NA	3.3	590
LSD 0.25			NA	NA	2.3	410

+ Compost rates were based on dry weight.
≠ The 1.0x fertilizer rate consisted of 160 lbs N, 90 lbs P_2O_5, 120 lbs K_2O, and 24 lbs S/A.
NA Denotes that the LSD value is not given because the compost x fertilizer interaction was not significant at the $P \leq 0.25$ level.

Table 9. Effect of fertilizer on second stubble yield parameters at Youngsville in 1994.

Fert.	Stalk Wt.	CRS	Cane yield	Sugar yield
	lbs	lbs/T	T/A	lbs/A
0	2.11	196	33.2	6,520
1.0x	2.14	193	35.1	6,750
LSD 0.10	NS	5	NA	NA
LSD 0.25	NS	3	NA	NA

NS Denotes that the treatment means were not different at the indicated P levels.
NA Denotes that the LSD is not given because the compost x fertilizer interaction was significant at the $P \leq 0.25$ level.

Table 10. Effect of compost on second stubble yield parameters at Youngsville in 1994.

Compost	Stalk wt.	CRS	Cane yield	Sugar yield
T/A	lbs	lbs/T	T/A	lbs/A
0	2.05	191	33.8	6,470
15	2.13	197	33.6	6,610
30	2.17	196	34.6	6,780
45	2.11	196	34.6	6,790
60	2.19	193	35.1	6,750
75	2.09	194	33.2	6,440
LSD 0.10	NS	NS	NA	NA
LSD 0.25	Ns	NS	NA	NA

NS Denotes that the indicated variables were not different at the indicated P levels.
NA Denotes that the LSD is not given because the compost x fertilizer interaction was significant at the $P \leq 0.25$ level.

SUGARCANE YIELDS AND FERTILIZER REQUIREMENTS[1] AS AFFECTED BY COMPOSTED MUNICIPAL WASTE

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SUMMARY

Due to concerns for the environment, many landfills are closed or are being closed. Solid waste from many municipalities in the state is presently trucked to landfills at distant sites at considerable cost. A possible solution to this problem is to make compost from sewage sludge and garbage for use in agricultural production. Our research was conducted to determine whether composted municipal waste, supplied by the Bedminster Bioconversion Corporation, can be safely and profitably used in growing sugarcane.

Research results over a four-year cane cycle with Bedminster compost showed that: 1) compost was low in heavy metals and fecal-coliform levels; 2) 10 T/A of compost semi-banded under cane at planting, when used with the recommended rate of commercial fertilizer, increased total sugar yields over four years by 8.6% (2,010 lbs/A at $0.21/lb sugar for an increase in gross income of $422.10); and 3) application of the recommended rate of commercial fertilizer where compost had previously been applied (semi-banded under cane at planting) resulted in a positive synergistic effect on sugarcane yields.

These results indicate that composted municipal waste can increase sugarcane yields and could be profitably used if it is priced sufficiently low.

INTRODUCTION

Municipalities face a growing problem of how to safely dispose of their sewage sludge and solid waste. At present, due to lack of land and concerns for the environment, many landfills are closed or are being closed. The landfill in Iberia Parish was closed several years ago and solid waste is now trucked out of the parish at considerable cost. Surrounding parishes face similar problems. A possible solution is to make compost from sewage sludge and solid waste. The compost could then be used for agricultural purposes.

One approach to making compost is that used by the Bedminster Bioconversion Corporation. The "Bedminster Process" combines one part sewage sludge with two parts solid waste in a "three day turning drum process". Moisture and temperature in the drum are kept

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[1] Research was supported by the Bedminster Bioconversion Corporation, American Sugar Cane League, Iberia Parish Council, City of New Iberia, Iberia Sugar Cooperative, Cajun Sugar Cooperative, Jeanerette Sugar Company, and M. A. Patout and Sons.

at approximately 50% and 160°F, respectively. Air is circulated as needed through the drum to keep the composting process aerobic and to prevent the temperature from going above 170°F, where the microorganisms responsible for composting die. Since fecal coliforms and other harmful microorganisms die during composting at temperatures lower than 150°F, the Bedminster Process results in a compost that is free from harmful microorganisms. Research is needed to determine whether composted municipal waste can be safely and profitably used in growing sugarcane.

Objectives of our study were to determine: 1) whether compost can be safely used in growing sugarcane; 2) the effect of compost on sugarcane yields; and 3) whether compost can be used to replace or supplement commercial fertilizer for sugarcane.

MATERIALS AND METHODS

In October, 1990, a fertilizer by compost study was initiated at the Iberia Research Station on a Baldwin silty-clay soil (fine, montmorillonitic, thermic Vertic Ochraqualf). Baseline soil samples were taken in September, 1990 at 0-6", 6-12", 12-24", and 24-36" and analyzed for the parameters given in Table 1. The experiment consisted of 12 compost and fertilizer treatments (Table 5), replicated three times in a randomized complete block design.

All plots received 0, 5, or 10 T/A of compost (Table 5) in opened rows in early October, 1990. The rows were then closed until planting. In late October the rows were opened and Kleentek variety CP65-357 was planted at three stalks and a lap of two joints. The rows were then closed to germinate the sugarcane.

In March of 1991, 1992, 1993, and 1994 the sugarcane rows were off-barred to allow the soil to warm up. In mid- to late April of each year, the fertilizer and compost rates indicated in Table 5 were applied to the left off-bar of each row; the rows were "hipped-up" to cover the compost and fertilizer in the off-bar; and cane was grown to maturity using standard cultural practices. The 1.0x fertilizer rate (tables 5, 6, and 7) was: 120, 60, and 80 lbs/A for N, P_2O_5, and K_2O, in 1991; 120, 60, 80, and 24 lbs/A for N, P_2O_5, K_20 and S in 1992; and 160, 90, 120 and 24 lbs/A for N, P_2O_5, K_2O, and S in 1993 and 1994. Nitrogen was applied as ammonium nitrate, phosphorus as polyphosphate, potassium as muriate of potash, and sulfur as gypsum.

In the fall of each of the four harvest years, plant population counts were made and the cane in each experimental plot was cut and weighed. A 10-stalk sample was taken from each plot to determine average stalk weight and juice quality. Statistical analyses were conducted using the Statistical Analysis System (SAS) with the 12 compost and fertilizer treatments serving as main-plots and harvest years as sub-plots.

RESULTS AND DISCUSSION

Table 1 shows the baseline analyses at four depths for the Baldwin silty-clay soil used in the study. Results indicate that soil pH and potassium were slightly low; all other measured nutrients were present in adequate amounts.

Chemical analyses of the Bedminster compost is given in Table 2. Results show that there were appreciable quantities of nitrogen, phosphorus, potassium, calcium, magnesium, iron, and sulfur in 10 tons of the compost, but lower amounts of manganese, copper, zinc, and boron. Heavy metal (copper, zinc, and nickel) concentrations in the compost were relatively low compared with those allowed by the Environmental Protection Agency (EPA). Applying compost at 10 T/A every four years, it would take 400 years to exceed the EPA level for copper, 444 years for zinc, and 800 years for nickel. This indicates that heavy metals were not a problem in the compost we used.

The compost was also analyzed for fecal coliform levels. Results showed that the compost had lower levels of fecal coliforms than the soil in the study to which it was applied (data not shown).

Table 3 shows the statistical analyses for the five yield parameters measured in the study. Compost and fertilizer treatments had a significant effect ($P \leq 0.10$) on weight of stalks at harvest, plant populations, cane yields, and sugar yields. Harvest year significantly affected stalk weights, plant populations, commercially recoverable sugar (CRS), cane yields, and sugar yields. Significant T x Y (treatment x year) interactions were found for plant populations, cane yields, and sugar yields.

Table 4 shows that CRS was highest for first stubble cane in 1992 and lowest for second stubble cane in 1993.

Effects of harvest year and compost and fertilizer treatments on cane tonnage are shown in Table 5. Average yields across the 12 treatments dropped from 35.1 T/A in 1991 for plant cane to 23.2 T/A in 1992 for first stubble. Tonnage then stabilized at 26.2 and 25.5 T/A, respectively, in 1993 and 1994 for second and third stubble. Applying 1 T/A of compost in the spring each year along with half the recommended rate of inorganic fertilizer did not increase ($P \leq 0.10$) sugarcane tonnage in any of the four harvest years or for total yields. However, semi-banding 10 T/A of compost under cane at planting in 1990 did increase ($P \leq 0.10$) tonnage in 1993 (T# 12 vs. T# 4). Applying 5 and 10 T/A of compost also increased total yields (T# 8 and 12 vs. T# 4), but only where the 1.0x rate of fertilizer was used. Increasing compost from 5 to 10 T/A (T# 8 vs. T# 12) resulted in a trend ($P \leq 0.25$) toward higher tonnage, but only where the full rate of commercial fertilizer was used.

Inorganic fertilizer increased cane tonnage each year for each of the three compost rates (0, 5, and 10 T/A) used in the study (Table 5). However, percentage yield responses to fertilization increased each year that the cane was grown. This emphasizes the importance of using adequate fertilizer so that yield decline in stubble crops is minimized.

Based on total yields, the 0.5x vs. 0 fertilizer rate increased tonnage significantly ($P \leq 0.10$) for each of the three 1990 compost rates (Table 5; T# 2 vs. T# 1, T# 6 vs. T# 5, and T# 10 vs. T# 9). Likewise, increasing the fertilizer rate from 0.5x to 1.0x improved yields at each compost rate (T# 2 vs. T# 4, T# 6 vs. T# 8, and T# 10 vs. T# 12). However, the total tonnage response from the 1.0x vs. 0 fertilizer rate was significantly greater at the 10 T/A compost rate than at the 0 or 5 T/A compost rate (Table 5, 49.8 T/A cane for the 10 T/A

compost rate vs. 41.7 T/A of cane for the 0 and 5 T/A compost rates). This indicates that the compost and fertilizer were acting synergistically to increase cane yields.

The significant ($P \leq 0.01$) treatment by year interaction for cane tonnage (Table 3) shows that compost and fertilizer treatment yields changed differentially with harvest crop. This is illustrated by dividing the 1994 cane yield by the 1991 cane yield for each of the 12 treatments (Table 5) which shows that adding 10 T/A of compost in the absence of fertilizer (T# 9) kept the 1994 yield at 0.50 of the 1991 yield, while not adding fertilizer in the absence of compost (T# 1) resulted in a yield ratio of 0.46 for 1994 relative to 1991. Likewise, increasing the fertilizer rate from 0 to 0.5x and 1.0x (T# 1 vs. T# 2 and 4; T# 5 vs. T# 6 and 8; and T# 9 vs. T# 10 and 12) resulted in an increased 1994/1991 yield ratio which demonstrates the importance of proper fertilization in reducing yield decline in stubble crops.

Table 6 shows the effect of compost and fertilizer treatments and harvest year on sugar yields. As with cane tonnage, adding 1 T/A of compost along with commercial fertilizer in the off-bar each spring did not increase ($P \leq 0.10$) total sugar yields for any of the three compost rates applied in 1990 (T# 3 vs. T# 2, T# 7 vs. T# 6, T# 11 vs. T# 10). Likewise, adding compost in the absence of fertilizer did not increase ($P \leq 0.10$) total sugar yields (T# 5 and 9 vs. T# 1), but using 5 and 10 T/A of compost with the full fertilizer rate increased sugar yields for the 5 and 10 T/A compost rate by 1,100 and 2,010 lbs/A, respectively (T# 8 and 12 vs. T# 4). And, while increasing the 1990 compost application from 5 to 10 T/A, where the 1.0x fertilizer rate was used (T# 8 vs. T# 12), did not increase ($P \leq 0.10$) total sugar yields, there was a trend ($P \leq 0.25$) toward higher yields (24,380 vs. 25,280 lbs sugar/A) with the higher compost rate.

As with cane tonnage, average sugar yields across the 12 treatments decreased appreciably from 1991 (plant cane) to 1992 (first stubble), and stabilized thereafter (Table 6). There was also a significant ($P \leq 0.05$) treatment x year interaction for sugar yields (Table 3), showing that the compost and fertilizer treatments had a differential effect on the decrease of sugar yields with harvest year. This was largely due to the effect of the inorganic fertilizer in slowing the yield decline in the stubble crops (compare the 1994/1991 yield ratio for each treatment to see this). Using the 1.0x vs. the 0 fertilizer rate kept 1994 sugar yields at 0.83 (T# 4), 0.81 (T# 8), and 0.82 (T# 12) of that for 1991, while the zero fertilizer rate resulted in 0.47 (T# 1), 0.50 (T# 5), and 0.53 (T# 9) ratios for 1994 relative to 1991. Also, applying 5 and 10 T/A of compost in the absence of commercial fertilizer (T# 5 and 9 vs. T# 1) helped reduce the decline in sugar yields from 1991 to 1994, but not where the 1.0x fertilizer rate was used (T# 12 and 8 vs. T# 4). This indicates that compost had some fertilizer value since it acted similar to commercial fertilizer in reducing yield decline in stubble crops.

Table 7 shows the effect of harvest year and compost and fertilizer treatments on sugarcane plant populations. Spring applied compost did not increase ($P \leq .10$) plant populations in any of the four years but did decrease populations in 1991 where 10 T/A of compost was applied (T# 11 vs. T# 10). Using the 1.0x fertilizer rate increased ($P \leq .10$) plant populations in 1991 (T# 4, 8, and 12 vs. T# 1, 5, and 9, respectively), 1992 (T# 4, 8, and 12 vs. T# 1, 5, and 9), 1993 (T# 8 and 12 vs. T# 5 and 9), and 1994 (T# 4, 8, and 12 vs. T# 1, 5, and 9). Increasing fertilization from 0.5x to 1.0x increased plant population in 1991 (T# 8 vs. T# 6), 1992 (T# 4 vs. T# 2, and T# 12 vs. T# 10), and 1994 (T# 12 vs. T# 10). The effects of the

0 vs. 1.0x fertilizer rates on plant populations increased from 1991 to 1994. This demonstrates that fertilization helps keep yields from declining in stubble crop (Table 5) through its effect on increasing plant population.

Table 8 shows that the average stalk weight across the 12 compost and fertilizer treatments was highest for plant cane (1991), dropped significantly for first stubble (1992), and was lowest for third stubble. Consequently, the decrease in stalk weight was partially responsible for the decrease in cane tonnage in stubble crops (Table 5).

The effect of compost and fertilizer treatments on stalk weights averaged across the four harvest years is given in Table 9. Spring-applied compost did not affect ($P \leq 0.01$) stalk weights (T# 3 vs. T# 2, T# 7 vs. T# 6, and T# 11 vs. T# 10). Fall-applied compost also had no significant effect on stalk weights (T# 7 and 11 vs. T# 3, and T# 8 and 12 vs. T# 4). Conversely, increasing the fertilizer rate from 0 to 0.5x and 1.0x resulted in appreciable increases in stalk weights (T# 1 vs. T# 2 and 4, T# 5 vs. T# 6 and 8, and T# 9 vs. T# 10 and 12). This increase in stalk weight with fertilization partially explains the effect of fertilizer on increased tonnage (Table 5). However, increasing fertilizer from 0.5x to 1.0x did not affect stalk weights (T# 2 vs. T# 4, T# 6 vs. T# 8, T# 10 vs. T# 12).

CONCLUSIONS

1) Composted municipal waste obtained from the Bedminster Bioconversion Corporation for use in growing sugarcane was low in heavy metals and fecal coliform levels.
2) Compost and fertilizer treatments affected sugarcane stalk weights, plant populations, cane tonnage, and sugar yields.
3) Harvest year affected stalk weights, plant populations, commercially recoverable sugar, cane tonnage, and sugar yield.
4) There was a significant harvest year interaction with compost and fertilizer treatments for plant population, and cane and sugar yields showing that the compost and fertilizer treatments differentially affected how sugarcane yields decline with stubble crops.
5) Compost applied in the off-bar each spring with commercial fertilizer did not affect cane tonnage or total sugar yields across four years of sugarcane growth.
6) Semi-banding 10 T/A of compost under cane at planting, in the absence of commercial fertilizer, did not increase cane or sugar yields across the four years in the study but did increase yields where the recommended fertilizer rate was used.
7) Semi-banding 10 T/A of compost under cane at planting, with the recommended rate of fertilizer, increased sugar yields by 2,010 lbs/A or $422,10 at a sugar price of $0.21/lb.
8) Cane and sugar yield response to fertilization was significantly higher where 10 T/A of compost vs. 0 compost was semi-banding under cane at planting, which shows that compost and fertilizer had a synergistic effect on yields.
9) The decrease in cane tonnage (with stubble crops and failure to add fertilizer) was associated with both decreased plant populations and stalk weights.
10) Compost applied under cane at planting appeared to have some fertilizer value.

Table 1. Soil analyses before adding compost.

	inches soil depth			
Variable+	0-6	6-12	12-24	24-36
pH	5.3	5.6	6.5	7.0
	- - - - - - - - - ppm - - - - - - - - -			
P	189	159	100	166
K	105	82	81	75
Ca	1780	1871	3209	4828
Mg	311	359	547	547
Cu	0.6	0.6	0.4	0.3
Mn	5.9	4.0	3.5	2.7
Zn	0.30	0.21	0.10	0.06
Fe	53	50	13	5
Na	27	34	61	73
		- - - - - - - - - -dS/m- - - - - - - - -		
EC	0.10	0.06	0.10	0.16

+Initial soil sample analyses (September, 1990). Soil pH was determined from a 2:1 (water:soil) extract. Values for Ca, Mg, Na, and K were exchangeable; those for P, Fe, Mn, Zn, and Cu were extractable.

Table 2. Chemical analysis of Bedminster composted municipal waste.

Element	Conc.	Content in 10 tons	Element	Conc.	Content in¶ 10 tons	EPA load
	ppm	lbs		ppm	lbs	lbs
N	11,000	220	C	390,000	7,800	
P	6,432	129	Cu	232	5	[500]
K	5,303	106	Zn	430	9	[1,000]
Ca	20,742	415	B	27	< 1	
Mg	2,188	44	Co	5	< 1	
Mn	295	6	Ni	22	< 1	[200]
Fe	22,681	454	Na	2,285	46	
S	3,792	76	Al	7,206	144	

¶The compost had a pH of 7.3.

Table 3. F-values for effect of fertilizer and compost treatments, and harvest year on sugarcane yield parameters.

Source	df	Stalk wt.	Plant population	CRS	Cane yield	Sugar yield
Treatments (T)	11	2.40*	27.75**	0.51	32.73**	58.96**
% CV		13.94	7.20	8.19	9.59	7.69
RMSE		0.2648	1973	15.55	2.637	399.5
Years (Y)	3	299.88**	15.65**	50.75**	253.09**	111.10**
TXY	33	0.89	1.61*	0.60	2.94**	1.74*
% CV		9.74	10.67	6.25	7.19	9.64
RMSE		0.1851	2922	11.87	1.977	500.5

* and ** denote statistical significance at the $P \leq 0.01$ and 0.05 levels, respectively. Remaining F-values were nonsignificant at $P \leq 0.10$.

Table 4. Effect of harvest year on commercially recoverable sugar averaged across compost and fertilizer treatments.

Year	CRS
	lbs/T
1991	185
1992	209
1993	176
1994	189
LSD 0.10	5
LSD 0.25	3

Table 5. Effect of fertilizer and compost on cane yields across four years.

T#	1990 compost	Fert.	Spring compost	Cane yields for+ 1991	1992	1993	1994	Total	1994 1991
	T/A		T/A	----------T/A----------					
1	0	0	0	30.6	16.2	20.0	14.1	80.9	0.46
2	0	0.5x	0	35.3	25.0	27.4	27.4	115.1	0.78
3	0	0.5x	1.0	34.2	24.8	27.6	27.4	114.0	0.80
4	0	1.0x	0	36.6	25.9	29.1	31.0	122.6	0.85
5	5	0	0	33.4	17.2	18.9	15.4	84.9	0.46
6	5	0.5x	0	36.6	23.2	26.6	29.3	115.7	0.80
7	5	0.5x	1.0	35.3	26.0	26.9	27.0	115.2	0.76
8	5	1.0x	0	37.8	26.9	30.3	31.6	126.6	0.84
9	10	0	0	30.5	16.9	19.4	15.3	82.1	0.50
10	10	0.5x	0	36.3	23.9	26.1	28.6	114.9	0.79
11	10	0.5x	1.0	35.2	24.8	28.8	27.6	116.4	0.78
12	10	1.0x	0	39.9	27.4	32.8	31.8	131.9	0.80
Avg.				35.1	23.2	26.2	25.5		

LSD 0.10	for effect of treatments on total cane yields.	7.2
LSD 0.25	for effect of treatments on total cane yields.	5.0
LSD 0.10	for effect of treatments on cane yields within years.	3.6
LSD 0.25	for effect of treatments on cane yields within years.	2.5
LSD 0.10	for effect of years on cane yields within treatments.	2.7
LSD 0.25	for effect of years on cane yields within treatments.	1.9

+The treatment x year interaction was significant at $P \leq 0.01$.

Table 6. Effect of fertilizer and compost on sugar yields across four years.

T#	1990 compost	Fert.	Spring compost	Sugar yields for+					1994
				1991	1992	1993	1994	Total	1991
	T/A		T/A	-lbs/A-					
1	0	0	0	5510	3370	3440	2570	14,890	0.47
2	0	0.5x	0	6520	5310	4560	5240	21,630	0.80
3	0	0.5x	1.0	6460	5220	4990	4880	21,550	0.76
4	0	1.0x	0	6850	5500	5260	5660	23,270	0.83
5	5	0	0	5920	3530	3200	2940	15,590	0.50
6	5	0.5x	0	6790	4890	4680	5860	22,220	0.86
7	5	0.5x	1.0	6630	5620	4620	5220	22,090	0.79
8	5	1.0x	0	7400	5550	5470	5960	24,380	0.81
9	10	0	0	5400	3530	3500	2860	15,290	0.53
10	10	0.5x	0	6820	5070	4510	5610	22,010	0.82
11	10	0.5x	1.0	6140	5020	4990	5020	21,170	0.82
12	10	1.0x	0	7570	5630	5860	6220	25,280	0.82
Avg.				6500	4850	4590	4840		

LSD 0.10	for effect of treatments on total sugar yields.	1,090
LSD 0.25	for effect of treatments on total sugar yields.	760
LSD 0.10	for effect of treatments on sugar yields within years.	540
LSD 0.25	for effect of treatments on sugar yields within years.	380
LSD 0.10	for effect of years on sugar yields within treatments.	680
LSD 0.25	for effect of years on sugar yields within treatments.	470

+The treatment x year interaction was significant at $P \leq 0.05$.

Table 7. Effect of fertilizer and compost on sugarcane plant populations across four years.

T#	1990 compost	Fert.	Spring compost	Plant populations for+ 1991	1992	1993	1994	1994 1991
	T/A		T/A	- - - - - 1000/A - - - - - -				
1	0	0	0	23.0	22.9	26.5	19.9	0.87
2	0	0.5x	0	24.4	29.3	26.9	31.3	1.28
3	0	0.5x	1.0	24.8	31.7	26.8	29.9	1.21
4	0	1.0x	0	26.5	32.3	29.1	30.9	1.17
5	5	0	0	25.0	25.2	22.4	23.6	0.94
6	5	0.5x	0	24.7	32.2	28.5	30.1	1.22
7	5	0.5x	1.0	24.3	31.2	28.8	28.8	1.19
8	5	1.0x	0	28.4	31.6	28.1	31.4	1.10
9	10	0	0	22.0	20.2	22.2	19.9	0.90
10	10	0.5x	0	26.8	29.8	26.5	29.9	1.12
11	10	0.5x	1.0	23.4	29.5	27.8	32.0	1.37
12	10	1.0x	0	26.0	36.6	28.5	32.7	1.26

LSD 0.10 for effect of treatments on plant populations within years. 2.7

LSD 0.25 for effect of treatments on plant populations within years. 1.9

LSD 0.10 for effect of years on plant populations within treatments. 4.0

LSD 0.25 for effect of years on plant populations within treatments. 2.8

+The treatment x year interaction was significant at $P \leq 0.05$.

Table 8. Effect of harvest year on stalk weights averaged across compost and fertilizer treatments.

Year	Stalk weight
	lbs
1991	2.57
1992	1.74
1993	1.81
1994	1.48
LSD 0.10	0.08
LSD 0.25	0.05

Table 9. Effect of fertilizer and compost on sugarcane stalk weights averaged across four years.

T#	1990 compost	Fert.	Spring compost	Stalk weight
	T/A		T/A	lbs
1	0	0	0	1.66
2	0	0.5x	0	1.95
3	0	0.5x	1.0	2.02
4	0	1.0x	0	1.98
5	5	0	0	1.76
6	5	0.5x	0	1.91
7	5	0.5x	1.0	1.94
8	5	1.0x	0	1.93
9	10	0	0	1.74
10	10	0.5x	0	1.96
11	10	0.5x	1.0	1.92
12	10	1.0x	0	2.03
LSD 0.10				0.13
LSD 0.25				0.09

KENAF AND SUGARCANE RESEARCH ON FIBER PRODUCTION IN 1994

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Agronomy Department

in cooperation with
St. Gabriel Research Station

SUMMARY

Experiments were conducted in 1994 to compare fiber production in Kenaf varieties and a wild sugarcane variety with different fertilizer treatments. In Kenaf, varieties EV 71, Cubano and Tainung 2 were tested with 0-0-0, 80-0-0, 160-0-0, and 160-40-80 lbs/A of NPK fertilizers. Tainung 2 produced a higher fiber yield than the other varieties. The stalk and fiber yields in each variety increased with each increment increase in fertilizer rates.

In sugarcane, a wild cane type variety L79-1002 was tested with 0-0-0, 160-0-0, and 160-60-120 lbs/A of NPK fertilizers. The N and NPK fertilizer treatments increased stalk weight and cane and sugar yields, but the differences between the treatments were small. The highest average yields of fiber produced were 16.4 T/A in Kenaf and 13.6 T/A in the wild cane. In addition to fiber, the cane produced 2999 lbs/A of sugar. The Kenaf contained bast and core fibers, and the cane contained typical bagasse fiber.

OBJECTIVES

The research was initiated to evaluate the potential of growing Kenaf and high-fiber sugarcane as alternate crops for the production of fiber.

RESULTS AND DISCUSSION

The following experiments were located on a Commerce soil on the St. Gabriel Research Station.

Kenaf Fiber Production

An experiment was conducted to test the effects of rates of fertilizer application with different varieties of Kenaf. The rates tested were 0-0-0, 80-0-0, 160-0-0, and 160-40-80 lbs/A of NPK fertilizers. The varieties tested with each rate were EV 71, Cubano, and Tainung 2. The fertilizer treatments were bedded in the rows prior to planting. The Kenaf plots were planted in two drills 22 inches apart on sugarcane size rows six feet wide. The seeding rate was 80,000 seeds per acre. Prowl was applied as a pre-emergence herbicide at planting time to control weeds. The plots were planted on May 5, and the crop was cut with a sugarcane harvester in November, 1994. All the stalks on each plot were weighed in the field. The drill and row spacings were chosen to accommodate sugarcane harvesting equipment so that the crop could be cut, weighed, and loaded mechanically at harvest time.

The stalk yield, average stalk weight, and percent fiber in the stalks were measured at harvest time. The percent bast and core fibers in the stalks were determined by crushing 10-stalk samples in a sugarcane laboratory mill and separating the fibers by hand. The percent and yield per acre of bast and core fibers were calculated for each plot.

The data obtained on the yield components of each variety and fertilizer treatment are reported in Table 1. The EV 71 and Cubano varieties produced similar stalk and fiber yields per acre but lower yields than Tainung 2. The increases in stalk yield from 80 and 160 lbs/A of N were significant and similar in each variety. The increase from 160-40-80 over N alone was significant in each variety except in EV 71. However, as an average of varieties, the stalk and fiber yields were increased significantly with each increment increase in fertilizer rates. The highest yield was produced in Tainung 2 with 160-40-80 lbs/A of NPK fertilizer.

The data obtained on the yield of bast and core fibers are reported in Table 2. Variety Tainung 2 was lower in percent bast fiber and higher in percent core fiber and total fiber yield per acre than the other varieties. As an average of varieties, the yields of bast and core fiber were increased with each increment increase in fertilizer rates. Tainung 2 with 160-40-80 lbs/A of NPK produced 6.5 T/A of bast fiber and 11.2 T/A of core fiber for a total fiber yield of 17.7 T/A.

Sugarcane Fiber and Sugar Production

An experiment was conducted to test the effects of fertilizer rates on the fiber and sugar production of a wild cane variety L79-1002. This cane variety is a progeny from crossing CP52-68 X Tianan 96. CP52-68 was a major variety grown in Louisiana in the 1960s and Tianan 96 is a wild type of sugarcane which grows without cultivation in Argentina. Variety L79-1002 is a high fiber cane with a high stalk population, small stalk diameter, and high stubbling ability.

Variety L79-1002 was planted in replicated plots and the fertilizer treatments were applied in plant cane in 1992, first stubble in 1993, and second stubble in 1994. The rates tested consisted of 0-0-0, 160-0-0, and 160-60-120 lbs/A of NPK. The treatments were applied in the spring and normal cane cultural practices were used during the growing season. The cane was cut with a cane harvester and weighed in November to measure the fiber, cane, and sugar yields. The stalk population and weight were determined at harvest time. A 20-stalk sample from each plot was used to measure the percent fiber and sucrose in the laboratory.

The data obtained in this test are reported in Table 3. The stalk population was very high and the average stalk weight was relatively low on each plot as compared with commercial cane. The N and NPK fertilizer treatments increased the stalk weight, cane, and sugar yields, but the differences in these yield components between the fertilizer rates were small. However, the 160-60-120 fertilizer produced the highest yields, which consisted of 37.1 T/A of cane stalks with 36.2% fiber and 13.6 T/A of dry fiber per acre. Also, the cane stalks contained 4.5% sucrose and produced 2999 pounds of sugar per acre.

Kenaf and Cane Fiber Comparison

The highest average yields of dry fiber produced were 16.4 T/A in Kenaf and 13.6 T/A in the wild sugarcane. The fiber yields were higher in Kenaf than cane and the types of fiber in each crop were different. Kenaf contained about one-third bast fiber and two-thirds core fiber. Bast fiber is long individual fibers and core fiber is soft and spongy fiber contained in the inter-core of the stalks. The bast and core fibers are used for different purposes in industry and must be processed separately. The cane fiber is typical bagasse fiber, generally used to burn and generate power in sugar mills. However, the wild cane also produced up to 2999 lbs/A of sugar equal to about one-half the average sugar yields of commercial cane varieties.

The Kenaf varieties and the wild cane variety were considerably taller than the maximum topping height of a cane harvester, and the fiber yields reported are lower than the yields actually produced in the field.

Table 1. Effect of varieties and fertilizer rates on the yield components of Kenaf grown on Commerce soil on the St. Gabriel Research Station, 1994.

Kenaf variety	Fertilizer $N-P_2O_5-K_2O$	Stalk			Fiber yield
		Yield	Weight	Fiber	
	lbs/A	T/A	lbs	%	T/A
EV 71	0-0-0	13.1	0.74	42.9	5.7
	80-0-0	24.7	0.91	45.1	11.2
	160-0-0	30.7	0.96	46.3	14.2
	160-40-80	32.9	1.41	47.0	15.5
Cubano	0-0-0	12.6	0.83	44.4	5.6
	80-0-0	24.7	1.08	42.2	10.4
	160-0-0	29.3	1.02	46.4	13.6
	160-40-80	33.1	1.33	48.6	16.0
Tainung 2	0-0-0	16.4	0.59	41.6	6.8
	80-0-0	29.5	1.08	43.0	12.7
	160-0-0	34.3	1.10	50.7	17.4
	160-40-80	39.7	1.13	44.6	17.7
LSD .05 Treatments		3.6			1.7
		Mean effect			
EV 71		25.4	1.01	45.3	11.6
Cubano		24.9	1.07	45.4	11.4
Tainung 2		30.0	0.98	45.0	13.7
	0-0-0	14.1	0.72	43.0	6.0
	80-0-0	26.3	1.02	43.4	11.4
	160-0-0	31.4	1.03	47.8	15.1
	160-40-80	35.2	1.29	46.7	16.4
LSD .05 Variety		1.8			0.8
LSD .05 Fertilizer		2.1			1.0

Table 2. Effect of varieties and fertilizer rates on the fiber yield of Kenaf grown on Commerce soil on the St. Gabriel Research Station, 1994.

Kenaf variety	Fertilizer $N-P_2O_5-K_2O$	Dry Fiber Yield			
		Bast Fiber		Core Fiber	
	lbs/A	%	T/A	%	T/A
EV 71	0-0-0	38.7	2.2	61.3	3.5
	80-0-0	39.7	4.4	60.3	6.7
	160-0-0	36.4	5.2	63.6	9.0
	160-40-80	36.4	5.7	63.6	9.8
Cubano	0-0-0	40.0	2.3	60.0	3.4
	80-0-0	36.8	3.8	63.2	6.6
	160-0-0	40.3	5.5	59.7	8.1
	160-40-80	38.2	6.1	61.8	9.9
Tainung 2	0-0-0	38.0	2.6	62.0	4.2
	80-0-0	32.6	4.1	67.4	8.6
	160-0-0	33.0	5.8	67.0	11.6
	160-40-80	37.1	6.5	62.9	11.2
LSD .05 Treatments			0.6		1.1
		Mean effect			
EV 71		37.8	4.4	62.2	7.3
Cubano		38.9	4.4	61.2	7.0
Tainung 2		35.2	4.8	64.8	8.9
	0-0-0	38.9	2.4	61.1	3.7
	80-0-0	36.4	4.1	63.6	7.3
	160-0-0	36.6	5.5	63.4	9.6
	160-40-80	37.2	6.1	62.8	10.3
LSD .05 Variety			0.3		0.5
LSD .05 Fertilizer			0.3		0.6

Table 3. Effect of fertilizers on the fiber and sugar yields of a wild cane variety L79-1002 on a Commerce soil in 1994.

Fertilizer N-P-K	Stalk		Dry Stalk Fiber Yield		Cane Yield	Stalk Sucrose	Sugar Yield
	No.	Wt.					
lbs/A	1000/A	lbs	%	T/A	T/A	%	lbs/A
0-0-0	65.4	0.65	37.8	8.1	21.4	3.5	1204
160-0-0	89.4	0.75	36.7	12.3	33.5	4.6	2833
160-60-120	83.9	0.84	36.2	13.6	37.1	4.5	2999
LSD .05	NS	0.10	NS	NS	6.7	NS	1237

Sucrose is expressed as percent of stalk weight. Variety L79-1002 is an F_1 progeny from crossing CP52-68 X Tianan 96 (a wild type cane from Argentina).

SUGARCANE RESPONSE TO WATER TABLE MANAGEMENT IN 1994

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In 1983, 17 acres of Commerce silt loam soil on the Westfield Plantation in Assumption Parish, Louisiana was subsurface drained to provide a facility to test the response of sugarcane to water table management. The subsurface drains were installed about 42 inches below the soil surface and were spaced 50 feet apart. Normally drains in silt loam soil are spaced 100 feet or more apart, but in this experiment 50-foot spacing was used to enhance the distribution of water in the soil profile during periods of subirrigation. The 17 acres was divided into three tracts. Seven drain lines in each tract emptied into a sump equipped with pumps that discharged the drain outflow into a surface drainage ditch. The pumps were turned on and off by switches with floats that responded to the rise and fall of the water level in the sump. Drain outflow into the sumps raised the water levels and the floats: pumping the outflow from the sumps lowered them. Irrigation wells were installed, one by each sump, to provide irrigation water. The well pumps were activated by float switches that were located inside the sumps. During irrigations, float switches were set so the water levels in the sumps were maintained at a relatively high level. This high water level in the sumps forced water through the subsurface drain lines into the soil profile and raised the water table into cane's root zone. The high water level was held long enough for the roots to become wetted, after which the water levels in the sumps and the fields were lowered to permit soil aeration.

The water management system at Westfield is usually operated in the subsurface drainage mode. Occasionally, during summer when evapotranspiration is high and rainfall is low, the water management system is switched to the subirrigation mode to irrigate the cane.

Nine sugarcane crops have been grown thus far in the water table management experiment. Crops were harvested from the first cycle in 1984, 1985, 1986 and in the second cycle in 1988 and 1989. In December 1989, just after the first stubble crop of the second cycle had been harvested, a severe freeze occurred that damaged the stubble to such an extent that it was plowed out in the spring of 1990. The fields were replanted with sugarcane variety CP 70-321 in the fall of 1990. The 1994 crop was third stubble (fourth crop) in this cycle.

Rainfall in 1994 at Westfield was 48.83 inches, 11.53 inches below normal. Only during the months of May, July, and September did rainfall amounts exceed the long term average. High rainfall amounts during these three months kept the soil moisture level reasonably high; therefore, the cane was not irrigated in 1994.

During the last week in October 1994, the third-stubble sugarcane crop was cut with a two-row harvester. Cane from four rows was placed in each heap. Four heap rows from each of three water management fields and two heap rows from each of two check fields (a total of 16 sub-areas) were used for yield estimates. In the water management fields, two heap rows were from near the subsurface drains and two were from midway between drains. For plant population estimates, stalks from 50 feet of each selected heap row were counted.

A cane loader was used to fill a wagon with cane from each selected heap row. The length of the heap row used in filling the wagon was measured to determine the area from which the cane was harvested. The cane was transported to the mill where each wagon load was weighed for yield estimates and sampled for sucrose. After the cane was loaded onto wagons, the cane stalks that remained in the four-row areas used for yield estimates were counted to determine the amount of cane left in the field.

The data for the 1994 crop are shown in Table 1. No distinction was made in Table 1 for yields measured from heap rows near subsurface drains and those measured mid-way between drains. Yields from these two locations within each subsurface drained field were essentially the same. The average cane yield from the three subsurface drained fields was 27.58 T/A. This is 8.22 T/A (42 percent) higher than the 19.36 T/A measured from the non-subsurface drained check (Table 1). The average sugar yield from the three subsurface drained fields was 6732 lbs/A. This is 1656 lbs/A (33 percent) higher than the 5076 lbs/A measured from the non-subsurface drained check (Table 1). It is interesting to note that sugar yield from drained fields was much higher than that from the non-subsurface drained fields in spite of the fact that sugar per ton from the check was about 18 lbs/ton (seven percent) higher. In other subsurface drainage experiments conducted by the author, there has been a tendency for check areas to have higher sugar concentrations some years. This is attributed to sugarcane growing, if it has a chance, rather than converting to sugar.

The commercial recoverable sugar concentration of 262 lbs/ton from the check area in 1994 (Table 1) was the highest sugar concentration measured in this experiment. This high sugar was from cane that was harvested early in the season, the last week in October. No sugarcane ripener was used. If harvest had been delayed a month, the sugar content of the cane juice may have been even higher.

In subsurface drained fields, the water table in the soil profile is usually kept below the zone in which the majority of cane roots exist. This low water table allows cane roots to grow deeper into the soil profile and thereby pick up extra nutrients that may be available. Furthermore, during droughts, cane plants with deep roots can pick up moisture from the soil profile that shallow-rooted crops in non-subsurface drained fields cannot reach.

The water table in each plot was measured continuously in 1994 from January to late October (harvest time). The water table in a non-subsurface drained (check) field was within the root zone (within 24 inches of the soil surface) for 24 days during 1994, while the water table in a subsurface drained field was within 24 inches of the soil surface less than one day (only 16.8 hours). Restricting the amount of time the water table was within the cane's root zone apparently impacted the 1994 yields considerably. Except for the subsurface drainage, the drained and non-drained fields were treated the same.

The average plant population in the subsurface drained fields was 30,459 plants/A with an average stalk weight of 1.82 lbs/stalk. In contrast, the average plant population in the check fields was 23,784 plants/A with an average stalk weight of 1.64 lbs/stalk. Thus, the higher cane yields (42 percent higher) measured from the subsurface drained area was due to both higher plant population (28 percent higher) and higher stalk weights (11 percent higher) than those

measured from the non-subsurface drained fields.

The amount of cane left in the fields after harvest was very small, only 0.12 T/A in the subsurface drained fields and 0.08 T/A in the check fields (Table 1). These data show that the sugarcane growers used high quality harvesting operations.

The data in this report highlight two very important economic aspects of growing sugarcane in Louisiana. The first item highlighted is that yields from subsurface drained areas were much higher than those from the non-subsurface drained (check) areas. The second item is that the high yields (from the subsurface drained areas) were from third stubble and the yields as well as the plant populations indicating that a fourth stubble crop may be possible. Obtaining above normal sugar yields and obtaining more than three sugarcane crops from one planting are two sugarcane production components that must be pursued for the future.

Acknowledgement: The author expresses appreciation to D. C. Mattingly and staff, Eugene Woods and staff, and the American Sugar Cane League for their roles in providing the experimental facility, sugarcane crop, and sugarcane weights and juice analysis.

Table 1. Data from water table management experiment at Westfield in Assumption Parish, Louisiana in 1994.

Plot (No.)	Cane yld. (T/A)	Sugar yld. (Lbs/T)	Sugar yld. (Lbs/A)	Stalk pop. Plants/A	Stalk wt. (Lb/stalk)	Cane left (T/A)
1 drained	26.5	250	6640	29003	1.83	0.122
2 drained	27.24	245	6673	31038	1.76	0.133
3 drained	28.99	237	6883	31336	1.86	0.121
Average	27.58	244	6732	30459	1.82	0.125
5 check	19.58	257	5035	22739	1.72	0.07
6 check	19.15	267	5117	24830	1.55	0.09
Average	19.36	262	5076	23784	1.64	0.08

ECONOMIC RESEARCH IN SUGARCANE IN 1994

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Projected costs and returns for the various stages of sugarcane production in Louisiana were estimated for the 1995 crop year. Production costs were estimated for farms using three-row machinery and production practices used by most growers in the main sugarcane producing areas. Specific operations for which production costs were estimated included field operations on fallow land, seedbed preparation, cutting and planting heat treated seedcane, planting cultured seedcane, field operations on plantcane, first stubble, second stubble, and third stubble, succession planting, as well as the costs of harvesting with one-row and two-row harvesters. Costs and returns were estimated for tenant-operators, reflecting the predominant land tenure situation, and reflect a mill payment of 39 percent of production and a land rent payment of 20 percent of the "after milling crop" proceeds (12.2 percent of production).

Expected raw sugar output per rotational acre is shown in Table 1. A normal sugarcane land rotation is assumed with 25 percent of land in plantcane, first stubble, second stubble, and fallow. Estimated costs and returns per rotational acre of land in sugarcane are shown in Table 2 for the River and Teche Regions for both sandy and clay soils. Residual returns above total specified expenses and overhead were higher for farms in the River Region than for farms in the Teche Region. Within each region, residual returns were slightly higher for sugarcane production on clay soils than on sandy soils. Table 3 presents estimated breakeven selling prices of raw sugar for selected yields to cover direct and total specified costs (excluding overhead). Raw sugar prices required to cover direct costs of production for tenant-operators at base level yields ranged from about $.15 per pound in the River Region to $.16 per pound in the Teche Region. Breakeven raw sugar prices to cover total specified production costs in these regions were $.19 and $.20 per pound, respectively.

Results of a study that evaluated the technical efficiency of sugarcane processing in Louisiana were published in 1994. Data for this study consisted of primary and secondary data obtained from raw sugar processing factories in Louisiana. Results of the study showed that the technical efficiency of sugar mills in Louisiana was high but decreasing over time. The high levels of estimated technical efficiency indicate that increased productivity would require new innovations or a higher level of technology to be introduced.

A study investigating sugarcane hauling costs concluded that opportunities may exist to significantly reduce hauling costs by coordinating hauling and processing activities among mills located in the same general area that have overlapping producer locations. Results indicated that delivering cane to the nearest mill could reduce hauling costs up to 10 percent. Although factors such as existing contractual relationships between mills and producers may limit the actual reduction in hauling costs which could be achieved, cooperation and coordination between mills and producers could contribute to reducing per unit hauling costs and help increase the long term competiveness of the industry.

Table 1. Expected Output per Rotational Acre for Tenants and Owner Operators, Sugarcane, Louisiana, 1995.

Item	Land Use	Plant Cane		1st Stubble		2nd Stubble		Marketable Output per Rotational Acre
		Tenant	Owner	Tenant	Owner	Tenant	Owner	
	(%)	Sugar Yield (lbs. of CRS)						
Land	100.0	5920	5920	4800	4800	4200	4200	
Harvested Rotational Cane 1/:								
Plant Cane	25.00	1480	1480	0	0	0	0	
Plant Cane for Seed 2/	4.17	247	247	0	0	0	0	
1st Stubble	25.00	0	0	1200	1200	0	0	
1st Stubble for Seed	0.69	0	0	33	33	0	0	
2nd Stubble	25.00	0	0	0	0	1050	1050	
Fallow	25.00	0	0	0	0	0	0	
Mill/Landlord Share:								
Mill	39.00	481	481	455	455	410	410	
Land Rent 3/	12.20	150	0	142	0	128	0	
Grower's Share 4/:								
Tenant		602	0	569	0	512	0	1684
Owner Operator		0	752	0	712	0	641	2105

1/ Assumes a normal land rotation of 25% each of plant cane, 1st stubble, 2nd stubble, and fallow.

2/ Assumes .694 acres of disease-free cultured seed planted annually with two expansions plus use of 1st stubble of seed for every 25 acres planted each year. One acre of cane cut for seed will plant five acres. Plant cane and 1st stubble cut for seed (4.86 acres) will plant 24.3 acres, plus .694 acres planted in new disease-free seed yields 25 acres planted.

3/ 20 percent of "after milling crop proceeds".

4/ Grower's share is total raw sugar less amount taken for mill share and land rent.

Table 2. Summary of Projected Costs and Returns per Rotational Acre of Land in Sugarcane, Tenant Operator, All Regions, Louisiana, 1995 1/.

Production Area	Adjusted Yield Per Acre 2/	Total Income 3,4,5/	Total Direct Costs	Returns Above Direct Costs	Total Fixed Costs	Total Specified Costs	Returns Above Specified Costs	Overhead Costs	Residual Returns
	--cwt--	dollars							
River Region									
Sandy Soils	16.84	398.28	248.41	149.87	68.35	316.76	81.52	46.76	34.76
Clay Soils	16.84	398.28	245.96	152.33	67.06	313.02	85.26	46.76	38.50
Teche Region									
Sandy Soils	16.84	398.28	267.06	131.22	69.63	336.69	61.59	46.76	14.83
Clay Soils	16.84	398.28	264.60	133.68	68.34	332.94	65.34	46.76	18.58

1/ Computations based on a normal 4-year rotation consisting of 25% each of fallow/plant, plant cane, 1st stubble, and 2nd stubble. Acres given up for seed include 4.17 acres of plant cane and .69 acres of 1st stubble.
2/ Reflects the raw sugar output to a tenant grower per rotational acre of land in sugarcane as specified in Table 1.
3/ Molasses output assumed to be 2.9 gallons per cwt. of raw sugar.
4/ Prices for raw sugar and molasses estimated at $21.50/cwt. and $0.38/gal., respectively.
5/ Includes the farm program market service payment on raw sugar (1.1% of the loan price per output unit) and contributions to the American Sugar Cane League check-off program.

Table 3. Breakeven Selling Prices for Raw Sugar for Selected Yields, Tenants, All Regions, Louisiana, 1995 1/.

Production Area	Selected Raw Sugar Yield Levels per Rotational Acre				
	(-20%)	(-10%)	Base	(+10%)	(+20%)
	1347	1515	1684	1852	2020
	----------dollars per lb.----------				
Breakeven, Direct Costs:					
River Region					
Sandy Soils	0.184	0.164	0.148	0.134	0.123
Clay Soils	0.183	0.162	0.146	0.133	0.122
Teche Region					
Sandy Soils	0.198	0.176	0.159	0.144	0.132
Clay Soils	0.196	0.175	0.157	0.143	0.131
Breakeven, Total Costs:					
River Region					
Sandy Soils	0.235	0.209	0.188	0.171	0.157
Clay Soils	0.232	0.207	0.186	0.169	0.155
Teche Region					
Sandy Soils	0.250	0.222	0.200	0.182	0.167
Clay Soils	0.247	0.220	0.198	0.180	0.165

1/ Excludes overhead costs.

1994 ASI FINAL MOLASSES SURVEY

ASI Staff
Audubon Sugar Institute

During the 1994 sugarcane harvest season weekly composites of final molasses samples were sent to Audubon For analysis. The people involved and their responsibilities were as follows:

Steve Clarke Monica Fontenot	Dilution of final molasses samples; Refractometer Brix and Pol analysis
Don Day Durriya Sarkar	Conductivity Ash
Michael Saska Mei Wu	Sugars analyszed by HPLC
Harold Birkett Jeanie Stein	Mailing survey bottles to factories; Calculation of data and communicating results to factories

Samples were analyzed for refactometer Brix, Pol, sucrose, glucose, fructose, and conductivity ash. From these analyses true purity, target purity, total sugars, and total sugars as invert were calculated. Results of the state average by week are given in Table 1 and shown in Figure 1. Results of the crop average for each factory are given in Table 2 and shown in Figure 2. Figure 3 shows results of the crop average for each factory in ascending order. Figure 4 shows results of the crop average for the past three years.

After the crop each factory's weekly samples were combined into two composites, one for each half of the crop. We would like to thank Mr. Hershel Morris and his staff at the Louisiana Department of Agriculture and Forestry's Agricultural Chemistry Division (formerly Feed & Fertilizer) for kindly doing the elemental analyses on these molasses composites. Table 3 shows the reults of the elemental analyses.

EQUIPMENT USED FOR ANALYSES

Apparent Purity:

Bellingham & Stanley Refactometer, Model RFM 90.
Rudolph Autopol IIS Saccharimeter.

This project was funded by the American Sugar Cane League.

Conductivity Ash:

Radiometer Copenhagen.

Sugars by HPLC:

Column:	Bio-Rad HPX-87, 300*7.8 mm at 85 deg. C.
Solvent:	0.01 M K_2SO_4.
Detector:	Waters 410 Differential Refactometer.
Integrator:	Spectra-physics SP4270 Integrator.
Pump:	Waters Associate Chromatography Pump, Model-M510.

LIST OF FORMULAS USED

Conductivity Ash = 0.0084 K C = 0.8, where K = cell constant (0.99 cm-1 and C = measured conductivity in microsiemens.

True Solids = 1 / (101.3 / Refractometer Brix + 0.932 / Sucrose) * 100.

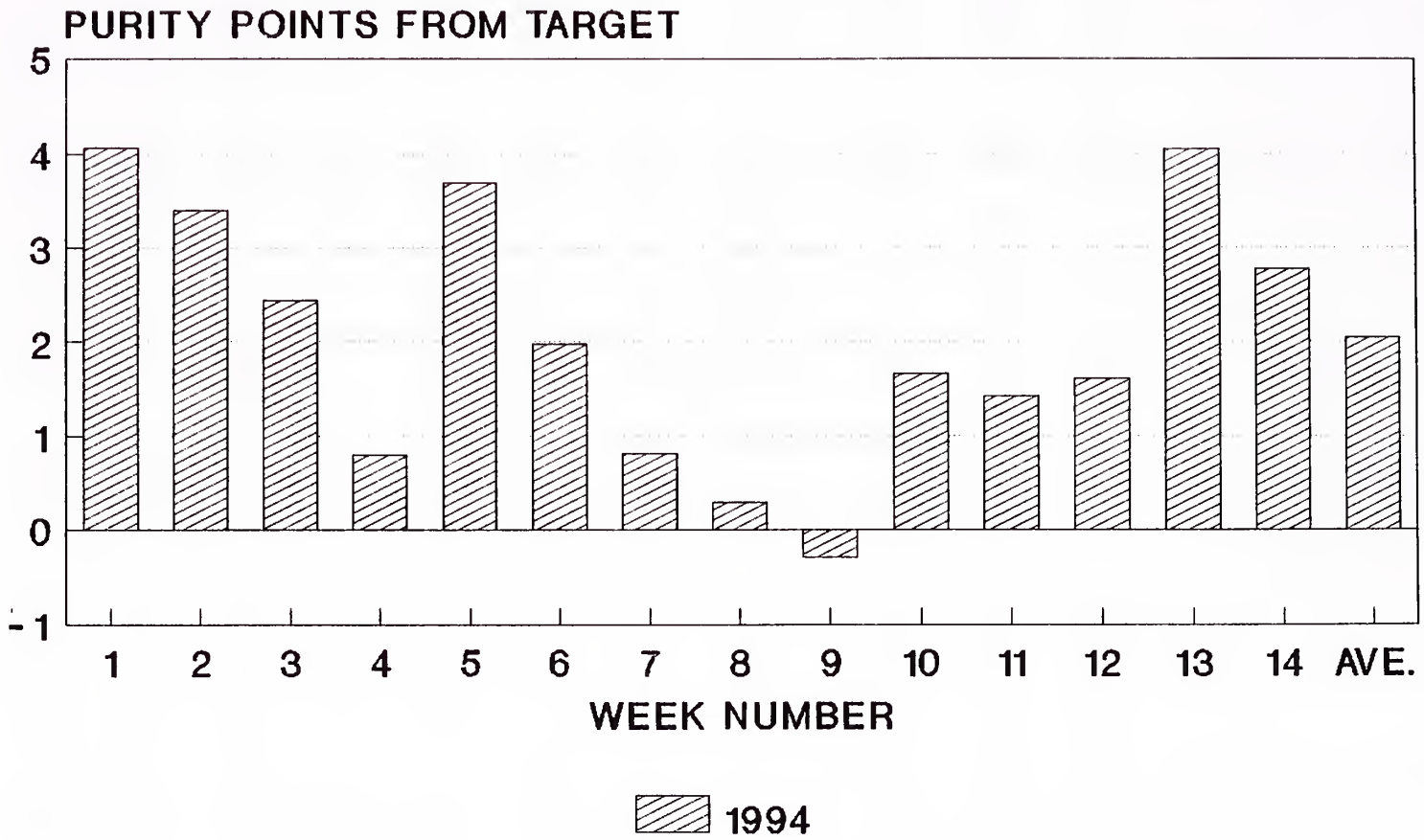
Target Purity = 42.4 - 12.3 log (Reducing Sugars by HPLC / Conductivity Ash).

Table 1. 1994 ASI Final Molasses Survey Results.

WEEK BY WEEK SUMMARY

W.E.	Ref. Brix	App. Purity	Glu-cose	Fruc-tose	Red. Sugars	Cond. Ash	RS/ Ash	True Solids	True Sucrose	True Purity	Target Purity	Diff.	Total Sugars	Tot. Sug. Invert
10/01/94	85.4	36.44	7.10	9.20	16.30	13.69	1.19	82.58	37.60	45.53	41.47	4.06	53.90	55.88
10/08/94	81.9	37.56	6.70	8.86	15.56	13.32	1.17	79.19	35.60	44.98	41.58	3.40	51.16	53.03
10/15/94	81.8	35.38	6.41	8.40	14.81	13.86	1.07	79.07	35.23	44.53	42.09	2.44	50.03	51.89
10/22/94	81.7	35.62	4.47	6.59	11.06	13.91	0.80	78.91	35.09	44.47	43.67	0.80	46.15	48.00
10/29/94	81.0	37.15	5.11	7.68	12.79	13.79	0.93	78.31	36.44	46.53	42.83	3.69	49.23	51.15
11/05/94	81.4	37.11	4.48	7.02	11.51	14.96	0.77	78.71	36.08	45.84	43.86	1.98	47.58	49.48
11/12/94	81.4	36.95	4.57	7.49	12.06	14.46	0.84	78.62	34.75	44.20	43.40	0.81	46.81	48.64
11/19/94	81.3	37.28	4.61	7.35	11.95	14.86	0.81	78.59	34.50	43.89	43.59	0.30	46.45	48.27
11/26/94	81.3	37.49	4.45	7.16	11.61	15.01	0.78	78.53	34.15	43.49	43.79	-0.29	45.76	47.56
12/03/94	81.0	38.54	4.02	6.75	10.77	15.25	0.71	78.33	35.99	45.96	44.30	1.66	46.76	48.66
12/10/94	81.1	39.01	3.68	6.44	10.12	15.43	0.66	78.44	36.15	46.10	44.68	1.42	46.27	48.17
12/17/94	81.2	39.44	3.76	6.39	10.16	15.20	0.68	78.55	36.31	46.21	44.61	1.60	46.47	48.38
12/24/94	81.1	43.75	2.70	5.25	7.95	15.56	0.52	78.57	39.35	50.07	46.03	4.05	47.30	49.37
12/31/94	81.4	43.44	2.00	4.70	6.70	16.39	0.41	78.86	39.40	49.96	47.18	2.78	46.10	48.17
Average	81.6	38.23	4.58	7.09	11.67	14.69	0.81	78.95	36.19	45.84	43.79	2.05	47.86	49.76

FIGURE 1
1994 STATE AVERAGE TRUE PURITY LESS TARGET PURITY BY WEEK

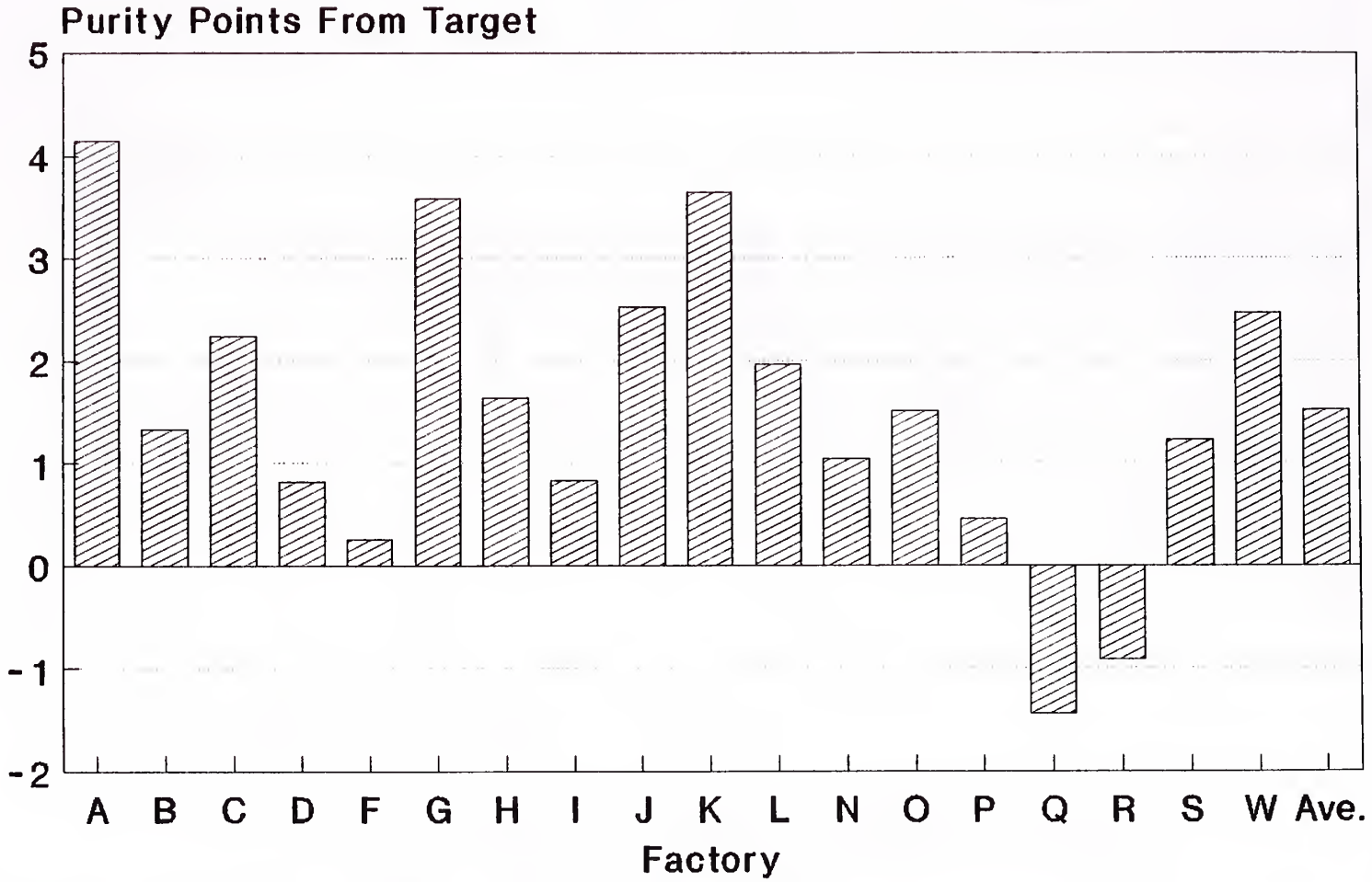


Week No. 1 = Week Ending 10/01/94
ASI Final Molasses Survey Results

Table 2. 1994 ASI Final Molasses Survey.

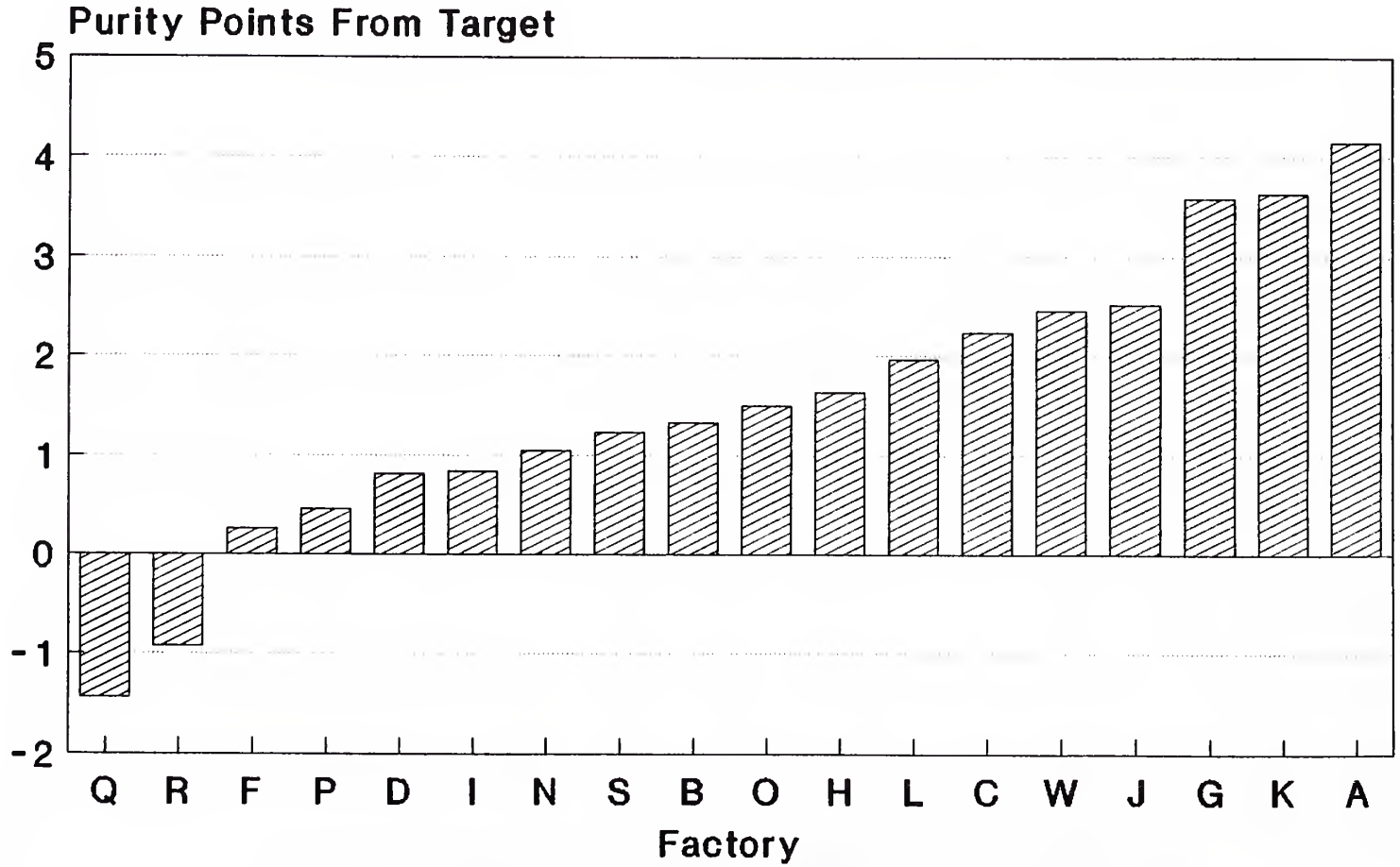
CROP AVERAGE BY FACTORY														
Factory	Ref. Brix	App. Purity	Glu-cose	Fruc-tose	Red. Sugars	Cond. Ash	RS/ Ash	True Solids	True Sucrose	True Purity	Target Purity	Diff.	Total Sugars	Tot. Sug. Invert
A	81.1	41.06	4.53	6.45	10.98	13.80	0.80	78.46	37.48	47.77	43.63	4.15	48.47	50.44
B	80.0	38.07	3.70	5.91	9.61	14.58	0.66	77.33	35.56	45.99	44.65	1.33	45.17	47.04
C	81.2	38.31	4.77	7.33	12.10	13.98	0.87	78.51	35.67	45.42	43.19	2.24	47.77	49.64
D	83.4	38.29	3.82	6.51	10.33	16.05	0.65	80.62	36.74	45.58	44.77	0.81	47.08	49.01
F	83.1	36.72	4.32	6.70	11.02	14.87	0.75	80.29	35.56	44.29	44.04	0.25	46.58	48.45
G	79.3	40.03	4.45	6.78	11.23	13.69	0.82	76.73	36.13	47.08	43.49	3.59	47.35	49.25
H	81.6	38.14	5.01	7.28	12.29	14.38	0.86	78.92	35.43	44.88	43.25	1.63	47.72	49.59
I	81.6	35.80	5.62	7.36	12.98	15.05	0.87	78.88	34.75	44.06	43.23	0.83	47.74	49.57
J	85.4	36.38	5.58	8.32	13.90	14.87	0.94	82.59	37.43	45.33	42.80	2.52	51.33	53.30
K	79.4	39.11	4.94	7.21	12.15	14.31	0.86	76.79	36.08	47.00	43.36	3.64	48.23	50.13
L	79.9	36.84	4.82	7.31	12.13	14.70	0.83	77.26	35.11	45.46	43.50	1.96	47.24	49.09
N	79.6	37.11	4.79	7.61	12.40	14.68	0.85	76.96	34.15	44.38	43.35	1.04	46.55	48.35
O	83.9	38.14	4.74	7.56	12.30	13.61	0.91	81.09	36.05	44.46	42.97	1.50	48.35	50.25
P	79.6	36.52	4.35	7.45	11.80	14.66	0.81	76.89	33.86	44.04	43.59	0.45	45.66	47.44
Q	81.9	34.31	4.40	7.40	11.80	14.76	0.80	79.02	33.33	42.17	43.62	-1.44	45.13	46.88
R	79.4	34.37	4.52	7.88	12.40	14.18	0.88	76.69	32.39	42.23	43.16	-0.92	44.79	46.49
S	81.9	38.92	3.55	6.68	10.23	15.64	0.67	79.19	36.49	46.09	44.86	1.23	46.72	48.64
W	81.1	38.64	4.03	6.25	10.28	15.17	0.68	78.44	36.88	47.02	44.56	2.46	47.16	49.10

FIGURE 2
STATE AVERAGE VS INDIVIDUAL FACTORIES
TRUE PURITY LESS TARGET PURITY



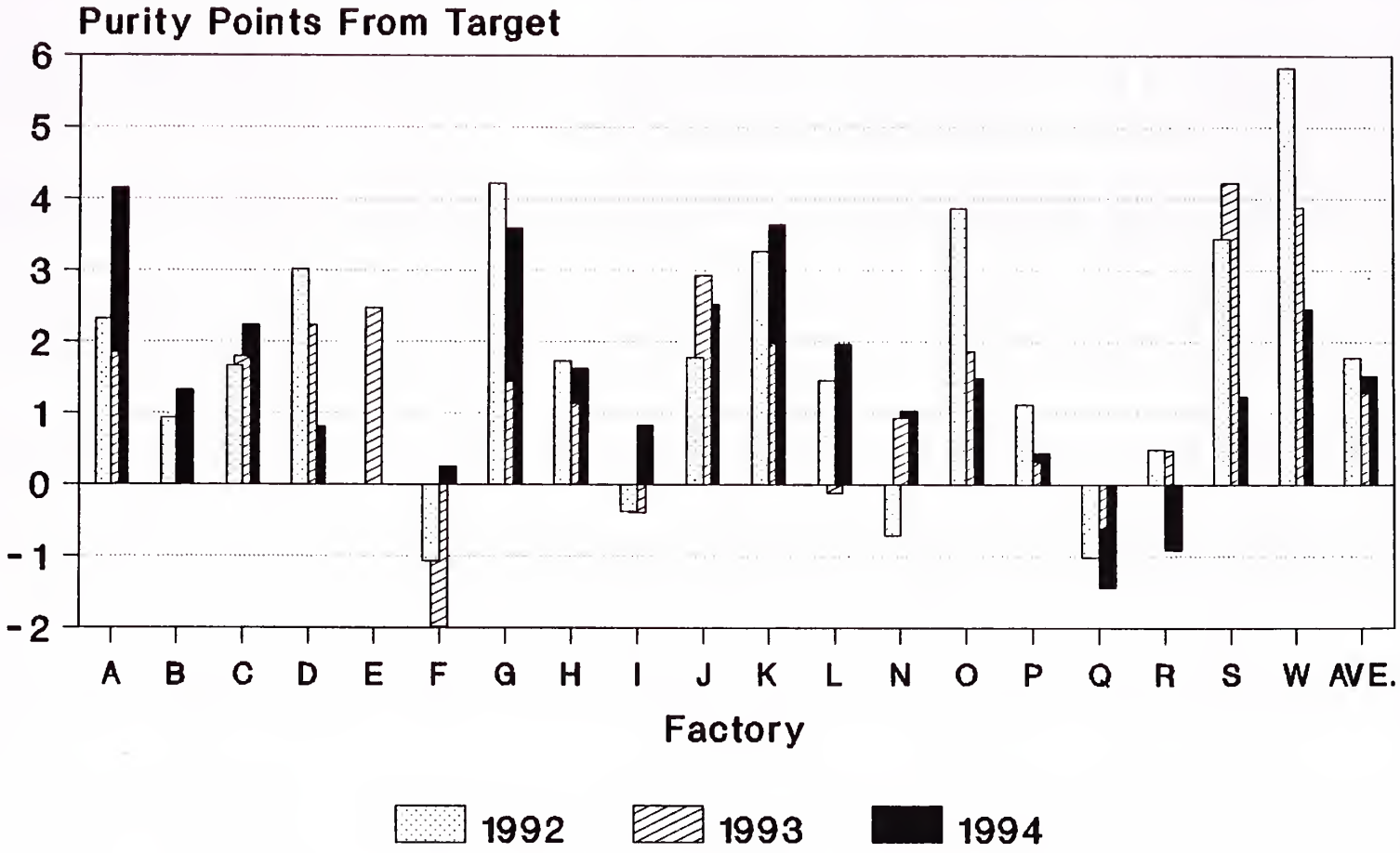
1994 ASI Final Molasses Survey Results

FIGURE 3
1994 STATE AVERAGE TRUE PURITY LESS TARGET PURITY BY FACTORY



ASI Final Molasses Survey Results
In Ascending Order

FIGURE 4
ASI DELTA TARGETS FOR ALL FACTORIES
1992-94 MOLASSES SURVEY RESULTS



No data for Factory E 1992 & 1994.

Table 3. 1994 Elemental Analysis by Agricultural Chemistry Division for the ASI Final Molasses Survey.

Factory	Potassium (%)	Chloride (%)	Calcium (%)	Sulfur (%)	Magnesium (%)	Silica (%)	Phosphorus (ppm)	Sodium (ppm)	Iron (ppm)
A-1	4.44	0.89	0.692	0.247	0.307	0.485	961	390	96.0
A-2	4.30	1.00	0.767	0.282	0.304	0.333	978	365	78.3
B-1	4.47	1.10	0.706	0.386	0.342	0.423	781	572	120.6
B-2	4.88	1.51	0.730	0.482	0.378	0.344	925	399	87.3
C-1	4.23	0.83	0.581	0.375	0.334	0.528	1046	394	100.6
C-2	4.33	0.94	0.609	0.448	0.331	0.231	1091	532	101.8
D-1	3.87	2.00	0.711	0.318	0.515	0.256	825	544	138.7
D-2	4.73	2.33	0.764	0.429	0.600	0.222	826	694	80.8
F-1	4.05	1.92	0.691	0.364	0.516	0.316	776	566	101.1
F-2	4.06	2.25	0.707	0.434	0.539	0.371	760	596	83.5
G-1	3.45	0.98	0.468	0.323	0.283	0.422	878	292	110.3
G-2	4.35	1.17	0.579	0.461	0.344	0.275	1066	333	94.9
H-1	4.16	1.47	0.702	0.299	0.391	0.856	615	417	171.1
H-2	4.59	1.57	0.716	0.354	0.387	0.362	821	319	97.8
I-1	3.56	2.19	0.629	0.354	0.464	0.427	824	562	81.0
I-2	4.01	2.56	0.837	0.503	0.557	0.587	810	743	70.8
J-1	4.43	1.86	0.570	0.368	0.434	0.412	875	359	111.9
J-2	4.85	2.34	0.629	0.414	0.516	0.203	1088	405	67.3
K-1	3.79	1.29	0.611	0.377	0.317	0.471	647	475	104.9
K-2	4.04	1.68	0.682	0.411	0.388	0.326	684	803	111.2
L-1	3.62	1.57	0.759	0.305	0.444	0.689	740	682	152.1
L-2	4.01	2.03	0.705	0.395	0.463	0.351	699	859	80.6
N-1	3.30	1.56	0.618	0.273	0.391	0.252	616	646	115.7
N-2	4.42	2.10	0.799	0.442	0.521	0.207	670	455	96.3
O-1	4.69	0.56	0.541	0.277	0.322	0.189	912	948	89.3
O-2	4.36	0.78	0.541	0.352	0.342	0.191	796	1348	60.5
P-1	3.76	1.36	0.727	0.412	0.329	0.379	628	402	160.6
P-2	4.18	1.57	0.717	0.463	0.347	0.376	650	337	124.7
Q-1	4.18	1.32	0.744	0.413	0.410	0.382	893	1062	188.0
Q-2	4.59	1.54	0.604	0.482	0.393	0.330	1116	717	87.8
R-1	3.77	1.03	0.607	0.343	0.340	0.357	687	797	177.9
R-2	4.19	1.27	0.578	0.417	0.369	0.450	861	936	110.9
S-1	3.85	2.34	0.627	0.384	0.456	0.316	613	748	100.0
S-2	4.28	2.79	0.714	0.489	0.515	0.298	701	985	69.1
W-1	3.63	2.07	0.541	0.241	0.386	0.351	935	1189	179.0
W-2	4.20	2.53	0.599	0.338	0.508	0.608	819	1501	84.4

1994 MILLING TESTS

Harold Birkett and Jeanie Stein
Audubon Sugar Institute

During the 1994 crop, 23 milling tests were conducted at 18 factories. Prepared cane and bagasse samples from each mill in the tandem were collected. These samples were analyzed for pol moisture, fiber, and ash content using standard methods. Moisture % bagasse, pol % bagasse, and individual and cumulative pol extractions were determined for each mill tested. In all but two tests, preparation index of prepared cane was determined. In addition, at 17 factories the % open cells in the bagasse leaving each mill in the tandem was also determined.

The % open cells was measured by first dividing a sample into two subsamples. One subsample was washed for 30 minutes using a tumbler turning at approximately 19 rpm while the other sample was digested using a Waring blender for 5 minutes. Both samples were made up to have the same sample to water ratio of 10:1. The percentage of open cells was calculated as the difference between the digested pol % fiber and the washed pol % fiber divided by the pol % fiber in cane expressed as a percent.

Preliminary density tests were also conducted at St. James from December 6-8, 1994. The core lab press container was filled with bagasse samples taken from each mill along with prepared cane. Samples collected on December 6 were pressed for 3 minutes at hydraulic pressures of 500, 1500, and 2500 psig. Samples collected on December 7-8 were pressed for 3 minutes at hydraulic pressures of 500, 1000, 1500, 2000, and 2500 psig. After pressing, the sample residue was weighed and analyzed for moisture % bagasse, fiber % bagasse, and ash % bagasse.

RESULTS

Results of each factory's moisture % bagasse, pol % bagasse, fiber % bagasse, ash % bagasse, individual mill extraction, cumulative pol extraction, and % open cells are given in Tables 1 through 7 and are summarized in Table 8.

Figures 1 through 6 show moisture % bagasse versus mill number for 4-, 5-, 6-, and 7-mill tandems. Figure 7 shows moisture % bagasse versus mill position. This is a normalized curve of all 115 data points collected in 1994. While it shows the average plot to be almost linear, a good moisture plot would be concave with each succeeding mill showing a lower moisture value. A plot of moisture % bagasse for each mill in a tandem is a good way of indicating which mills are working well and which could be improved.

Fiber % bagasse versus mill number for 4-, 5-, 6-, and 7-mill tandems is shown in figures 8 through 13. Fiber % bagasse should be increasing with every mill. Figure 14 shows the average plot for fiber % bagasse versus mill position for all 115 data points collected this past crop.

Figures 15 through 20 show the individual mill pol extraction for each mill in 4-, 5-, 6-, and 7-mill tandems. A good extraction for first mills would be between 50-60%. A good last mill extraction would range from 40-50%. In-between mills usually average about 30%.

All first mill extractions measured in 1994 are shown in Figure 21. Values ranged from 6-68% and averaged 45%. All last mill extractions are shown in Figure 22. The average was 36% with a range of 19-59%.

Figure 23 shows individual mill pol extraction versus mill position for data collected in 1994. The average plot is shown along with individual data points. As in past years, the data for 1994 shows that first and last mills receive the most attention.

Cumulative pol extraction versus mill number 4-, 5-, 6-, and 7-mill tandems are shown in Figures 24 through 29. Figure 30 shows the average plot for all 118 extraction points. The average pol extraction for the tandem was about 89%.

Figures 31 through 35 show the % open cells throughout 4-, 5-, 6-, and 7-mill tandems. On average, regardless of the preparation index, by mill 4 at least 96% of cells are opened and by the last mill 98-99% of cells have been opened. Average, high, and low curves for data collected are shown in Figure 36.

The remaining plots shown (figures 37 through 46) were obtained from density tests conducted at St. James. Beginning with figures 37 and 38, moisture % bagasse versus hydraulic pressure is plotted for prepared cane samples along with bagasse collected after each mill in the tandem. As shown prepared cane samples under no pressure had a moisture % cane of 75-78. The same prepared cane samples under 2500 psig of hydraulic pressure had 43-45% moisture. This can be seen with bagasse, going from a moisture of 53% out of the tandem down to 36% when placed under 2500 psig.

Figures 39 and 40 show fiber % bagasse versus hydraulic pressure for prepared cane and mill bagasse samples. As expected the fiber % bagasse increases as the pressure applied increases.

Figures 41 and 42 show bagasse density versus hydraulic pressure for prepared cane and mill bagasse samples. Densities ranged from about 75-92 lbs/cu.ft.

Fiber densities for mill samples are shown for different hydraulic pressures in figures 43 and 44. In these plots, fiber densities (lbs fiber/cu.ft.) were calculated by multiplying the fiber % bagasse by the corresponding density determined for each sample. Overall values ranged from about 28-49 lbs fiber/cu.ft.

Figures 45 and 46 show data plotted for fiber+ash density versus hydraulic pressures of 500-2500 psig. These values were obtained by adding the ash % bagasse (dry basis) to the fiber % bagasse and multiplying by the density. Prepared cane values ranged from 31-39 lbs (fiber+ash) /cu.ft. Bagasse values ranged from 38-53 lbs. (fiber+ash) / cu.ft.

Table 1

Moisture % Bagasse

Factory	Mill Number							
	PC	1	2	3	4	5	6	7
F-1	70.67	59.73	55.34	53.13	54.74			
F-2	71.87	-	-	-	51.94			
U-1	72.47	66.57	63.94*	69.21*	51.07			
C-1	70.71	58.68	54.02	54.73	56.93	52.78		
D-1	71.94	66.18	65.33	67.20	68.04	57.51		
D-2	74.10	-	-	-	-	57.93		
K-1	70.87	58.66	58.21	58.13	56.33	51.33		
Q-1	72.22	63.51	62.08	57.04	53.63	52.05		
Q-2	70.83	60.80	55.87	55.16	54.22	50.28		
A-1	69.70	71.94	62.02	55.14	55.06	58.28	49.23	
A-2	71.52	64.25	-	-	-	-		
B-1	73.73	60.67	59.02	57.51	58.64	56.02	54.85	
E-1	71.00	59.59	60.66	53.93	56.04	56.80	50.94	
G-1	72.25	61.45	55.50	54.81	54.59	57.24	51.77	
H-1	71.73	56.18	59.02	55.37	53.07	50.27	50.92	
I-1	71.94	64.43	60.74	59.13	59.96	65.84	56.63	
J-1	73.58	70.10	-	57.95	-	-	51.37	
L-1	73.24	72.65	71.01	68.61	66.32	59.59	53.87	
L-2	73.05	71.10	70.69	69.83	62.81	60.66	55.66	
N-1	74.05	62.97	60.85	58.55	55.49	76.48*	52.59	
O-1	71.00	63.24	60.29	61.26	58.97	65.27	53.44	
W-1	74.98	69.83	65.10	60.82	64.45	61.29	56.56	
W-2	71.66	71.03	63.71	57.69	58.12	57.86	52.66	
S-1	71.24	64.66	62.97	58.93	58.04	59.39	63.37	53.80

* Sample includes imbibition.
- means no data.

Excessive juice going over top roll may have contributed to high moistures at any mill.

Table 2

Pol % Bagasse

Factory	Mill Number							
	PC	1	2	3	4	5	6	7
F-1	11.09	9.18	7.19	4.67	3.62			
F-2	11.61	-	-	-	3.09			
U-1	10.84	7.56	6.09*	3.91*	4.45			
C-1	12.74	10.13	7.35	5.32	3.63	2.62		
D-1	12.95	10.52	8.66	6.67	5.24	3.32		
D-2	11.11	-	-	-	-	3.88		
K-1	12.13	9.65	8.03	6.21	6.12	4.03		
Q-1	11.15	8.91	8.19	6.74	5.80	4.42		
Q-2	12.13	9.56	7.15	5.88	5.20	3.67		
A-1	11.57	11.28	8.18	6.89	5.49	4.28	3.08	
A-2	12.65	10.82	-	-	-	-	-	
B-1	10.74	8.74	7.42	6.23	5.21	3.92	2.91	
E-1	11.65	9.27	8.06	6.46	5.19	3.69	2.57	
G-1	12.01	9.31	7.81	5.55	3.88	2.94	2.12	
H-1	12.18	8.53	7.95	5.96	4.97	3.57	2.46	
I-1	12.74	10.27	8.29	6.74	5.99	4.33	4.25	
J-1	11.66	9.86	-	6.62	-	-	3.45	
L-1	10.68	10.21	9.67	8.73	8.61	6.43	4.79	
L-2	11.42	11.12	9.71	8.84	7.55	6.30	4.75	
N-1	11.55	10.10	7.94	6.26	5.13	2.08*	3.25	
O-1	13.04	11.43	8.81	6.85	6.06	4.25	3.76	
W-1	11.73	10.41	9.54	6.41	4.89	3.62	2.49	
W-2	12.34	11.48	10.19	7.63	6.15	4.58	3.37	
S-1	12.01	10.38	8.38	6.67	5.27	3.89	3.06	2.48

* Sample included imbibition.
- means no data.

Table 3

Fiber % Bagasse

Factory	Mill Number							
	PC	1	2	3	4	5	6	7
F-1	14.81	27.02	32.55	37.08	36.33			
F-2	13.92	-	-	-	39.46			
U-1	14.53	22.41	24.93*	24.66*	37.41			
C-1	13.33	26.33	33.19	34.44	33.48	39.15		
D-1	15.07	20.65	22.54	22.78	22.13	34.40		
D-2	13.11	-	-	-	-	33.04		
K-1	12.62	23.85	27.75	28.69	30.84	37.49		
Q-1	12.01	22.11	24.42	29.28	32.87	36.41		
Q-2	13.69	25.07	30.17	33.28	35.16	39.18		
A-1	14.87	15.45	26.30	31.53	33.87	31.26	41.70	
A-2	12.25	21.82	-	-	-	-	-	
B-1	12.52	25.45	27.15	29.94	29.25	31.94	34.01	
E-1	14.69	25.93	27.13	34.20	32.41	34.06	38.95	
G-1	12.71	24.90	30.51	32.62	35.29	33.41	40.19	
H-1	12.99	28.34	26.63	33.91	31.04	36.13	37.60	
I-1	11.44	21.18	25.92	28.73	29.20	26.78	32.54	
J-1	12.55	16.49	-	30.50	-	-	38.60	
L-1	13.44	13.82	15.70	20.51	20.82	28.73	34.40	
L-2	13.19	14.04	14.67	17.24	24.41	27.00	32.21	
N-1	12.49	23.83	28.76	30.14	34.08	20.17*	40.20	
O-1	13.48	22.40	27.27	28.28	30.54	25.71	37.82	
W-1	12.93	18.10	20.79	28.88	26.03	30.19	35.37	
W-2	13.78	15.25	23.00	29.52	30.23	31.70	37.88	
S-1	12.77	21.03	25.40	30.37	32.75	31.32	29.91	39.18

* Fiber low due to contamination with water.
- means no data.

Table 4

Ash % Bagasse

	Mill Number							
Factory	PC	1	2	3	4	5	6	7
F-1	1.00	1.20	1.29	1.33	1.36			
F-2	1.01	-	-	-	1.16			
U-1	0.64	1.61	1.17*	0.86*	1.69			
C-1	1.06	1.58	1.50	1.69	1.79	1.89		
D-1	0.71	0.96	1.00	0.94	1.04	1.34		
D-2	1.01	-	-	-	-	1.05		
K-1	2.03	-	2.17	2.71	2.71	3.02		
Q-1	2.03	2.15	2.12	2.47	2.18	2.43		
Q-2	0.81	1.13	1.32	1.61	1.58	1.37		
A-1	0.76	0.83	1.28	1.44	1.23	1.34	1.59	
A-2	0.77	0.96	-	-	-	-	-	
B-1	2.21	2.30	2.46	2.38	2.89	3.70	2.56	
E-1	0.87	1.36	1.23	1.46	1.33	1.26	1.18	
G-1	0.72	1.07	1.17	1.21	1.39	1.26	1.31	
H-1	1.62	3.42	2.86	3.30	3.19	4.59	4.01	
I-1	0.96	1.21	1.31	1.41	1.20	0.98	1.32	
J-1	0.88	1.33	-	2.05	-	-	2.95	
L-1	1.46	1.14	1.66	1.32	1.81	1.72	2.08	
L-2	1.04	1.85	2.10	1.62	1.41	1.59	1.79	
N-1	0.65	0.95	1.06	1.09	1.15	0.61*	1.08	
O-1	0.74	0.88	0.98	1.22	1.26	1.11	1.36	
W-1	0.88	1.05	2.08	1.24	1.32	1.25	1.39	
W-2	0.79	0.80	1.18	1.46	1.58	1.27	1.51	
S-1	0.75	0.82	0.89	1.09	1.00	0.94	0.91	0.99

* Sample included imbibition.
- means no data.

Table 5

Individual Mill Extraction

Factory	Mill Number 1	2	3	4	5	6	7
F-1	54.63	34.99	42.96	20.83			
F-2	-	-	-	-			
U-1	54.76	27.59	35.06	25.09			
C-1	59.74	42.46	30.26	29.75	38.31		
D-1	40.68	24.64	23.81	19.07	59.19		
D-2	-	-	-	-	-		
K-1	57.90	28.51	25.17	8.41	45.75		
Q-1	56.58	16.76	31.43	23.33	31.12		
Q-2	56.99	37.85	25.44	16.21	36.75		
A-1	6.18	57.40	29.74	25.84	15.52	46.01	
A-2	51.99	-	-	-	-	-	
B-1	59.96	20.46	23.84	14.49	31.12	30.20	
E-1	54.93	16.90	36.47	15.17	32.43	39.13	
G-1	60.43	31.49	33.56	35.46	19.88	40.00	
H-1	67.93	0.72	41.16	8.80	38.38	33.80	
I-1	56.48	33.98	26.68	12.63	21.21	19.20	
J-1	35.65						
L-1	7.03	16.62	30.90	2.78	45.87	37.78	
L-2	8.49	16.49	22.51	39.67	24.51	36.88	
N-1	54.16	34.89	24.76	27.55	31.53	21.48	
O-1	47.23	36.67	25.00	18.11	16.80	39.86	
W-1	36.69	20.20	51.67	15.36	36.20	41.19	
W-2	15.99	41.12	41.71	21.29	28.90	38.48	
S-1	47.56	33.14	33.40	26.75	22.85	17.62	38.08

- means no data.
F-2 and D-2 were tests with only prepared cane and last mill samples.
A-2 was repeat run of mill test A-1 at side of roll excluding juice overflow.

Table 6

Cumulative Pol Extraction

Factory	Mill Number 1	2	3	4	5	6	7
F-1	54.63	70.50	83.18	86.68			
F-2	-	-	-	90.62			
U-1	54.76	67.24	78.73	84.06			
C-1	59.74	76.83	83.84	88.65	93.00		
D-1	40.68	55.30	65.94	72.44	88.75		
D-2	-	-	-	-	86.12		
K-1	57.90	69.91	77.48	79.37	88.81		
Q-1	56.58	63.86	75.22	81.00	86.91		
Q-2	56.99	73.27	80.07	83.30	89.44		
A-1	6.18	60.03	71.92	79.18	82.41	90.50	
A-2	51.99	-	-	-	-	-	
B-1	59.96	68.15	75.74	79.26	85.72	90.03	
E-1	54.93	62.54	76.20	79.81	86.36	91.70	
G-1	60.43	72.89	81.99	88.38	90.69	94.41	
H-1	67.93	68.16	81.27	82.91	89.47	93.03	
I-1	56.48	71.27	78.94	81.60	85.50	88.28	
J-1	35.65	-	76.65	-	-	90.38	
L-1	7.03	22.48	46.44	47.93	71.81	82.46	
L-2	8.49	23.58	40.78	64.27	73.03	82.98	
N-1	54.16	70.15	77.55	83.73	88.86	91.25	
O-1	47.23	66.58	74.94	79.48	82.93	89.73	
W-1	36.64	49.43	75.56	79.31	86.80	92.24	
W-2	15.99	50.54	71.17	77.30	83.86	90.07	
S-1	47.56	64.94	76.65	82.90	86.80	89.13	93.27

- means no data.

Table 7

% Open Cells

Factory	Mill Number							
	PC	1	2	3	4	5	6	7
F-1	73.47	88.42	91.57	97.01	98.17			
F-2	70.92	-	-	-	-			
U-1	48.18	83.58	85.87	92.55	94.85			
C-1	77.83	88.69	93.36	96.05	97.75	99.26		
D-1	71.46	88.77	92.19	94.13	97.05	98.78		
D-2	-	-	-	-	-	-		
K-1	71.10	88.41	93.52	95.46	96.53	98.16		
Q-1	77.41	89.21	92.60	94.98	96.27	98.28		
Q-2	80.79	88.68	95.11	96.90	97.34	99.21		
A-1	63.17	75.84	92.50	94.91	96.64	97.94	98.98	
A-2	-	-	-	-	-	-	-	
B-1	79.47	89.77	92.58	93.94	96.56	97.47	97.72	
E-1	66.10	83.57	91.58	94.49	96.44	97.85	98.75	
G-1	82.05	89.07	92.96	96.76	98.17	98.42	99.53	
H-1	78.42	91.51	94.08	96.69	97.23	98.86	99.53	
I-1	82.22	91.32	93.42	94.78	96.58	97.76	97.32	
J-1	63.31	-	-	-	-	-	97.77	
L-1	79.10	79.30	81.47	87.26	88.13	94.63	96.35	
L-2	69.80	81.42	82.45	89.63	92.33	94.03	96.42	
N-1	85.19	-	-	-	-	-	-	
O-1	83.42	91.98	91.43	94.09	94.73	96.41	97.74	
W-1	80.12	-	-	-	-	-	-	
W-2	80.89	85.34	88.31	92.63	94.04	96.68	98.21	
S-1	86.28	-	-	-	-	-	-	99.25

- means no data.

Table 8

SUMMARY OF 1994 MILL TESTS

Factory	Prep. Index	Pol % Cane	Fiber % Cane	Moist % Bag.	Pol % Bag.	Pol Ext.	Red. Ext.	Ash % Cane	Ash % Bag.
F-1	73.47	11.09	14.81	54.74	3.62	86.68	89.05	1.00	1.36
F-2	70.92	11.61	13.92	51.94	3.09	90.62	91.71	1.01	1.16
U-1	48.18	10.84	14.53	51.07	4.45	84.06	86.60	0.64	1.69
C-1	77.83	12.74	13.33	52.78	2.62	93.00	93.50	1.06	1.89
D-1	71.46	12.95	15.07	57.51	3.32	88.75	90.94	0.71	1.34
D-2	-	11.11	13.11	57.93	3.88	86.12	86.86	1.01	1.05
K-1	71.10	12.13	12.62	51.33	4.03	88.81	88.93	2.03	3.02
Q-1	77.41	11.15	12.01	52.05	4.42	86.91	86.30	2.03	2.43
Q-2	80.79	12.13	13.69	50.28	3.67	89.44	90.49	0.81	1.37
A-1	63.17	11.57	14.87	49.23	3.08	90.50	92.23	0.76	1.59
A-2	-	12.65	12.25	-	-	-	-	0.77	-
B-1	79.47	10.74	12.52	54.85	2.91	90.03	90.05	2.21	2.56
E-1	66.10	11.65	14.69	50.94	2.57	91.70	93.11	0.87	1.18
G-1	82.05	12.01	12.71	51.77	2.12	94.41	94.52	0.72	1.31
H-1	78.42	12.18	12.99	50.92	2.46	93.03	93.33	1.62	4.01
I-1	82.22*	12.74	11.44	56.63	4.25	88.28	87.04	0.96	1.32
J-1	63.31	11.66	12.55	51.35	3.45	90.38	90.42	0.88	2.95
L-1	79.10	10.68	13.44	53.87	4.79	82.46	83.86	1.46	2.08
L-2	69.80	11.42	13.19	55.66	4.75	82.98	84.00	1.04	1.79
N-1	85.19	11.55	12.49	52.59	3.25	91.25	91.24	0.65	1.08
O-1	83.42	13.04	13.48	53.44	3.76	89.73	90.58	0.74	1.36
W-1	80.12	11.73	12.93	56.56	2.49	92.24	92.53	0.88	1.39
W-2	80.89	12.34	13.78	52.66	3.37	90.07	91.12	0.79	1.51
S-1	86.28	12.01	12.77	53.80	2.48	93.27	93.43	0.75	0.99
Average:									
1994	75.03	11.82	13.30	53.21	3.43	89.34	90.08	1.06	1.76
1993	80.00	11.24	12.90	53.95	3.06	90.42	90.51	1.28	2.46

- means no data.
* Includes Cush-Cush

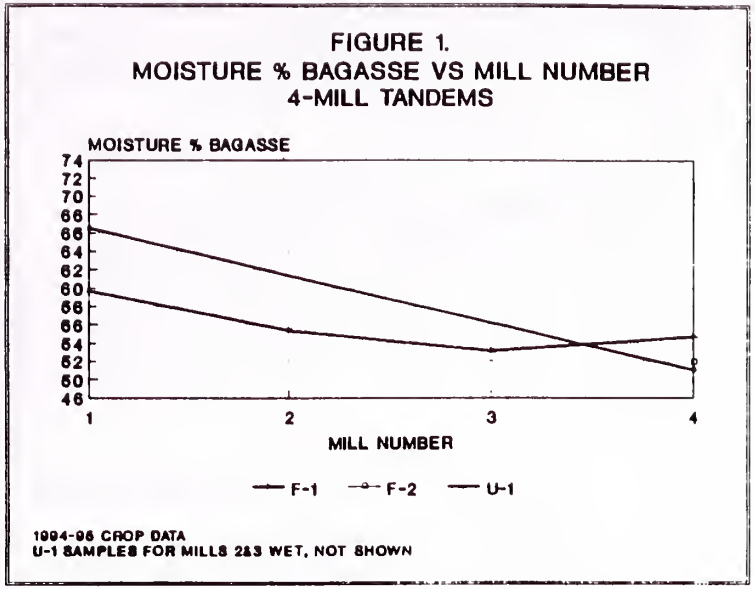


FIGURE 1.
MOISTURE % BAGASSE VS MILL NUMBER
4-MILL TANDEMS
MOISTURE % BAGASSE
74
72
70
68
66
64
62
60
58
56
54
52
50
48
1
2
3
4
MILL NUMBER
F-1
F-2
U-1
1994-95 CROP DATA
U-1 SAMPLES FOR MILLS 2&3 WET, NOT SHOWN

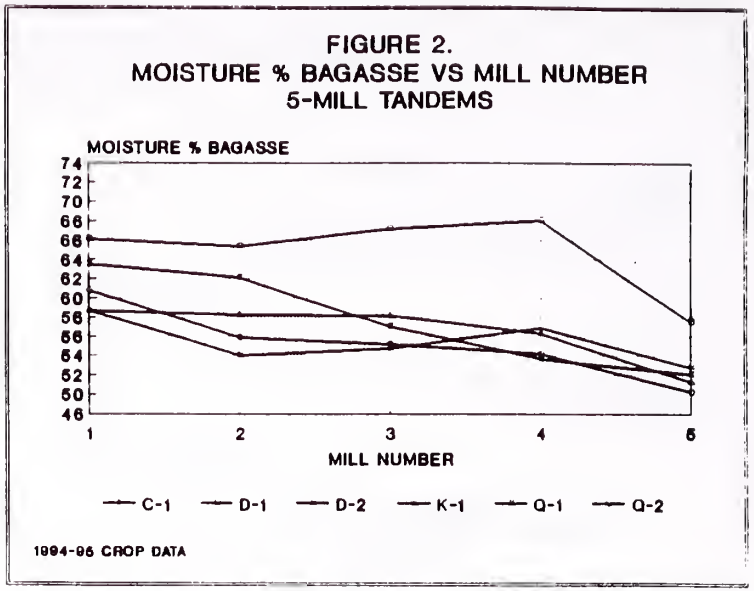


FIGURE 2.
MOISTURE % BAGASSE VS MILL NUMBER
5-MILL TANDEMS
MOISTURE % BAGASSE
74
72
70
68
66
64
62
60
58
56
54
52
50
48
1
2
3
4
5
MILL NUMBER
C-1
D-1
D-2
K-1
Q-1
Q-2
1994-95 CROP DATA

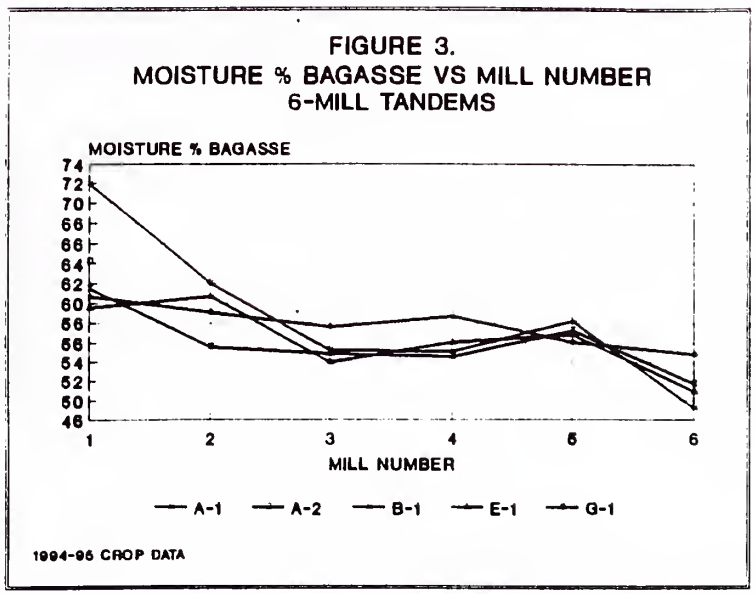


FIGURE 3.
MOISTURE % BAGASSE VS MILL NUMBER
6-MILL TANDEMS
MOISTURE % BAGASSE
74
72
70
68
66
64
62
60
58
56
54
52
50
48
1
2
3
4
5
6
MILL NUMBER
A-1
A-2
B-1
E-1
G-1
1994-95 CROP DATA

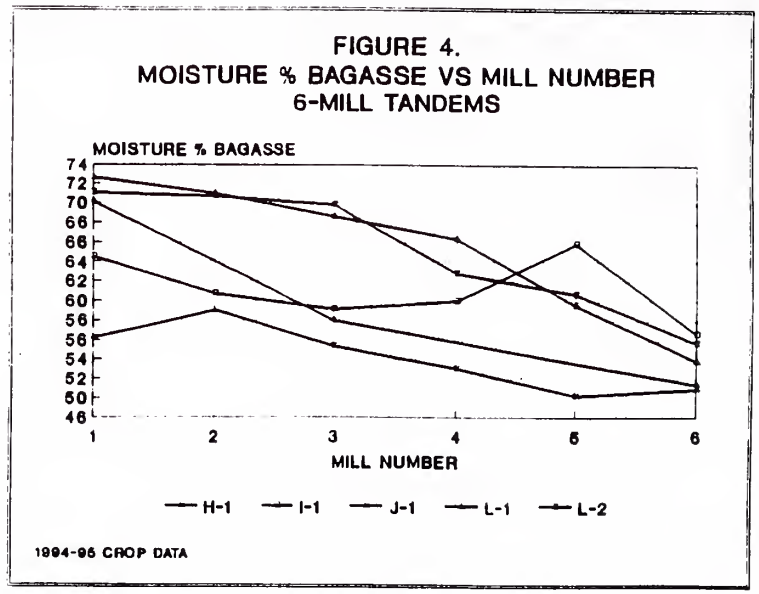
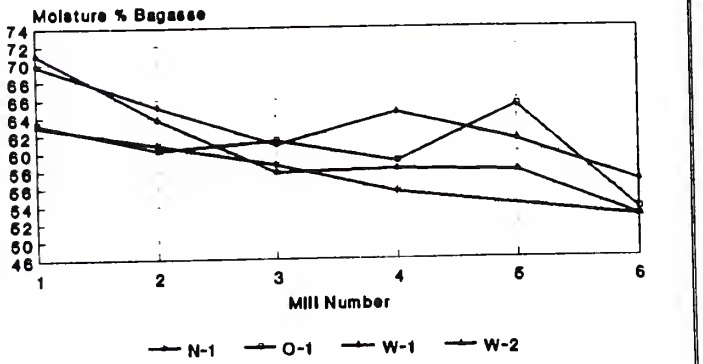


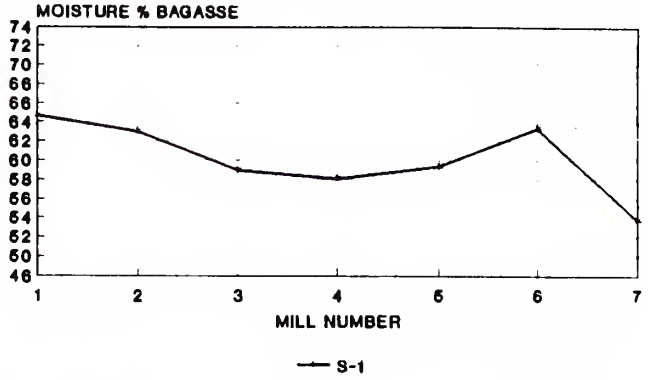
FIGURE 4.
MOISTURE % BAGASSE VS MILL NUMBER
6-MILL TANDEMS
MOISTURE % BAGASSE
74
72
70
68
66
64
62
60
58
56
54
52
50
48
1
2
3
4
5
6
MILL NUMBER
H-1
I-1
J-1
L-1
L-2
1994-95 CROP DATA

FIGURE 5.
MOISTURE % BAGASSE VS MILL NUMBER
6-MILL TANDEMS



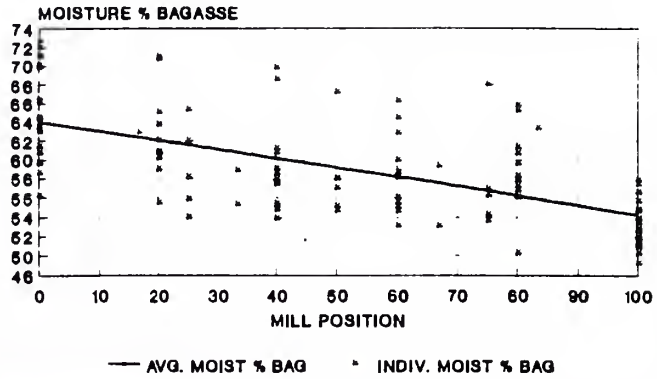
1994-95 CROP DATA
N-1 MILL 6 SAMPLE WET & IS NOT SHOWN

FIGURE 6.
MOISTURE % BAGASSE VS MILL NUMBER
7-MILL TANDEM



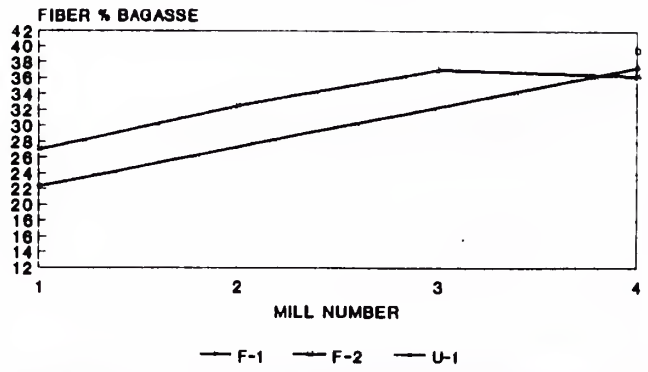
1994-95 CROP DATA

FIGURE 7.
MOISTURE % BAGASSE VS MILL POSITION



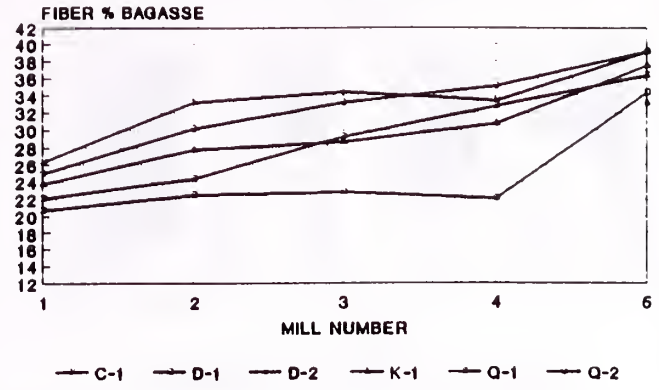
0 = MILL 1
100 = LAST MILL
1994-95 CROP DATA

FIGURE 8.
FIBER % BAGASSE VS MILL NUMBER
4-MILL TANDEMS



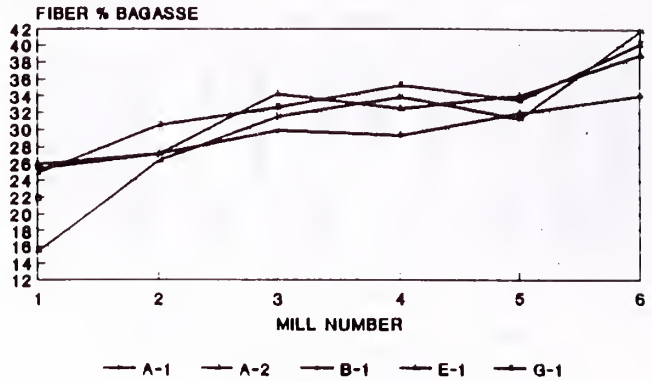
1994-95 CROP DATA
U-1 SAMPLES FOR MILLS 2&3 WET, NOT SHOWN

FIGURE 9.
FIBER % BAGASSE VS MILL NUMBER
5-MILL TANDEMS



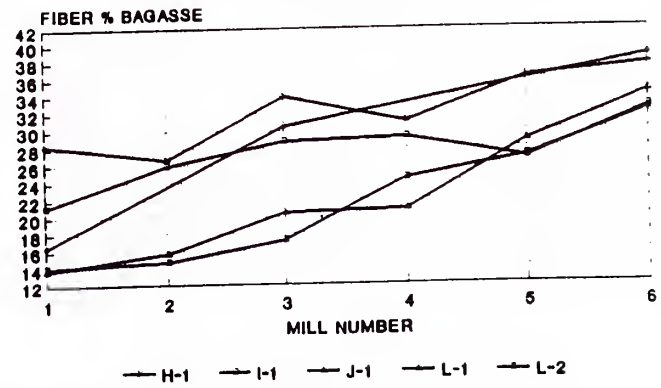
1994-95 CROP DATA

FIGURE 10.
FIBER % BAGASSE VS MILL NUMBER
6-MILL TANDEMS



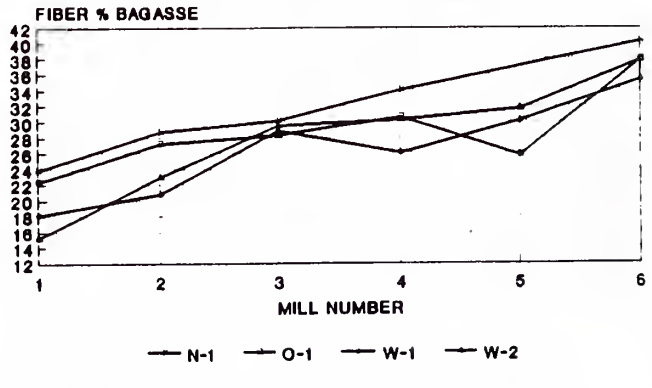
1994-95 CROP DATA

FIGURE 11.
FIBER % BAGASSE VS MILL NUMBER
6-MILL TANDEMS



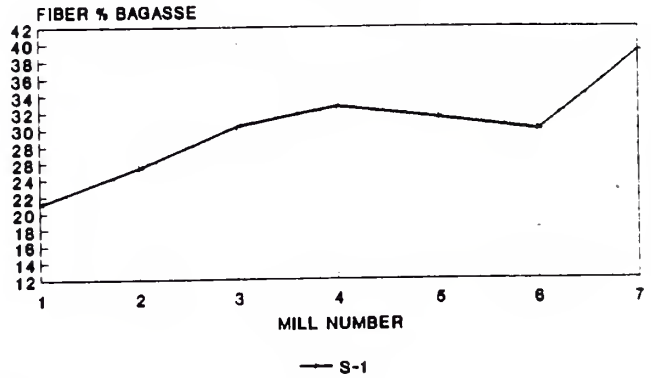
1994-95 CROP DATA

FIGURE 12.
FIBER % BAGASSE VS MILL NUMBER
6-MILL TANDEMS



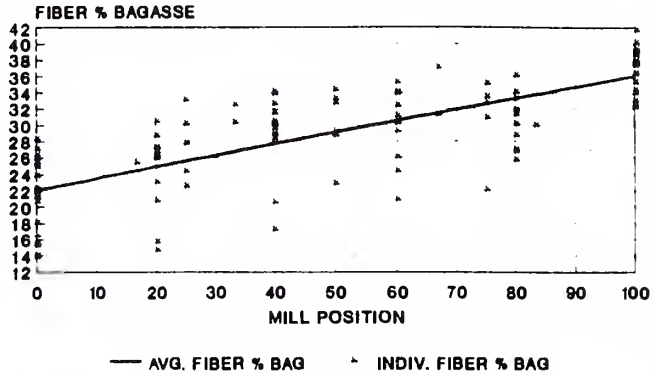
1994-95 CROP DATA
N-1 MILL 6 SAMPLE WET, NOT SHOWN

FIGURE 13.
FIBER % BAGASSE VS MILL NUMBER
7-MILL TANDEM



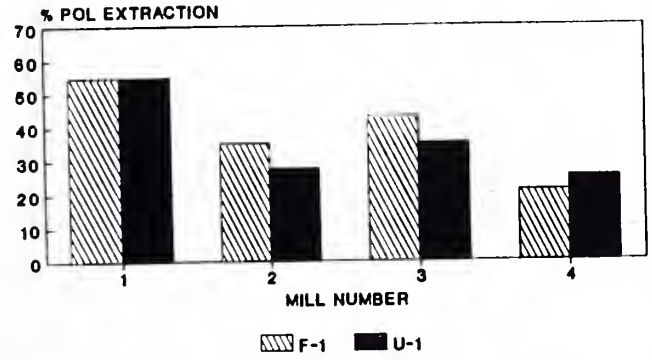
1994-95 CROP DATA

FIGURE 14.
FIBER % BAGASSE VS MILL POSITION



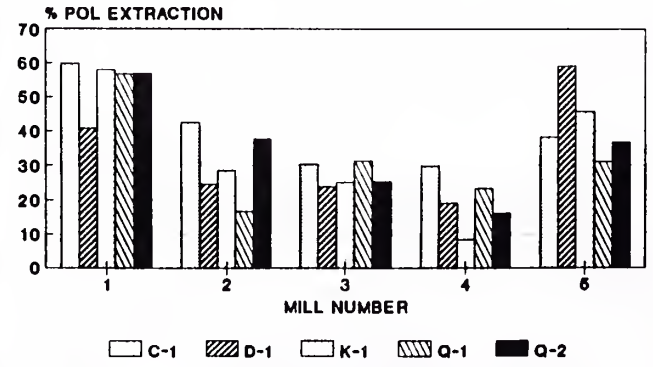
0 = FIRST MILL
100 = LAST MILL
1994-95 CROP DATA

FIGURE 15.
INDIVIDUAL MILL POL EXTRACTION
VS MILL NUMBER



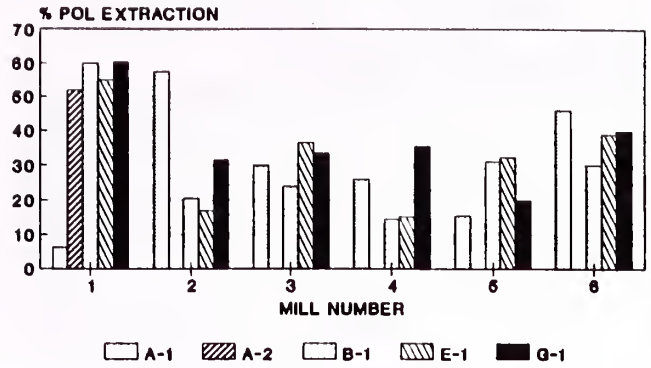
4-MILL TANDEMS
1994-95 CROP DATA

FIGURE 16.
INDIVIDUAL MILL POL EXTRACTION
VS MILL NUMBER



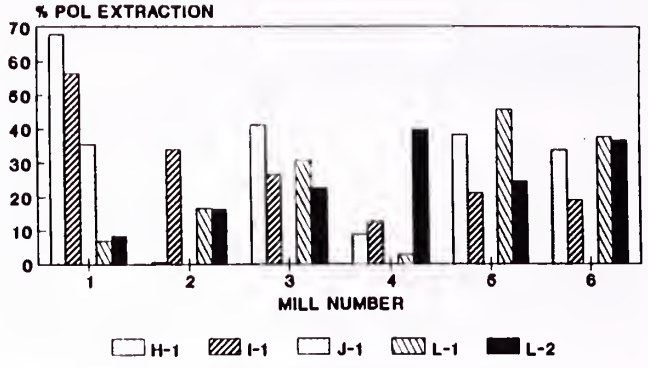
6-MILL TANDEMS
1994-95 CROP DATA

FIGURE 17.
INDIVIDUAL MILL POL EXTRACTION
VS MILL NUMBER



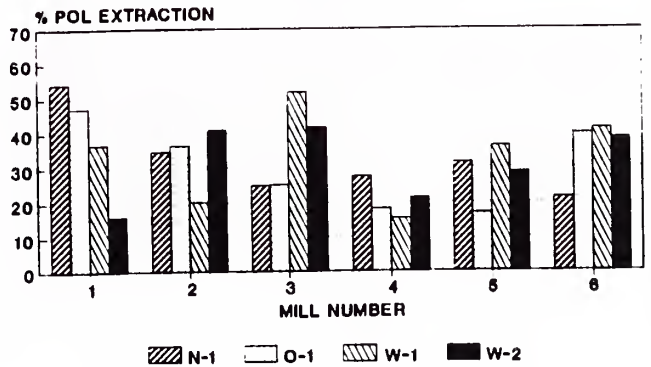
6-MILL TANDEMS
1994-96 CROP DATA

FIGURE 18.
INDIVIDUAL MILL POL EXTRACTION
VS MILL NUMBER



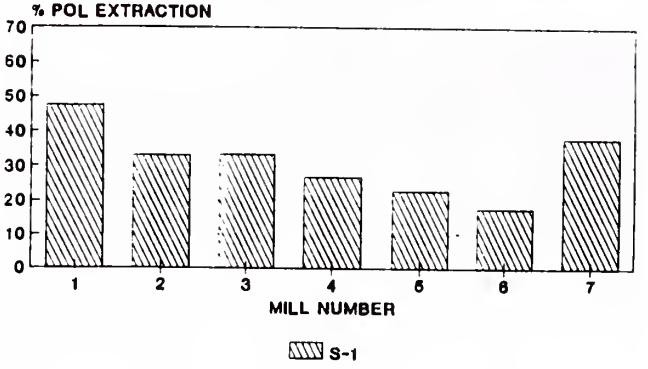
6-MILL TANDEMS
1994-96 CROP DATA

FIGURE 19.
INDIVIDUAL MILL POL EXTRACTION
VS MILL NUMBER



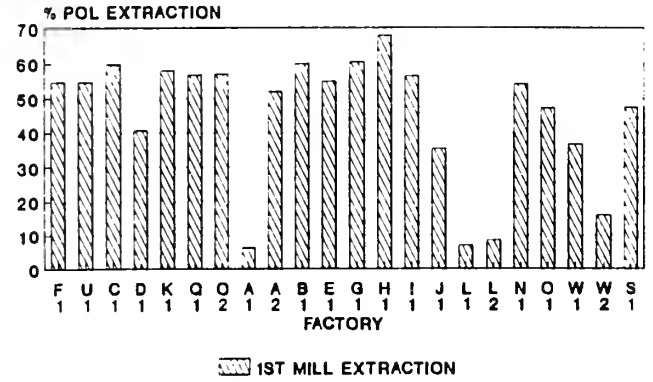
6-MILL TANDEMS
1994-96 CROP DATA

FIGURE 20.
INDIVIDUAL MILL POL EXTRACTION
VS MILL NUMBER



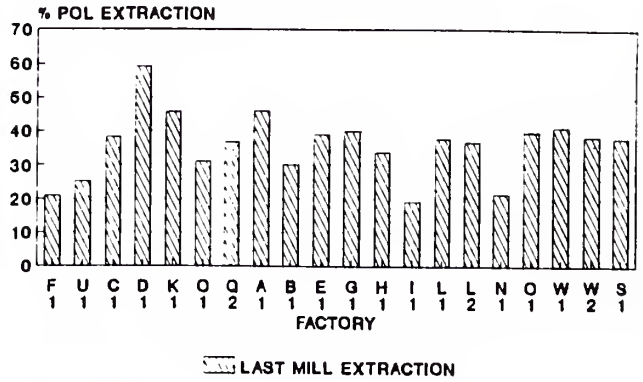
7-MILL TANDEM
1994-96 CROP DATA

FIGURE 21.
FIRST MILL POL EXTRACTION
VS FACTORY



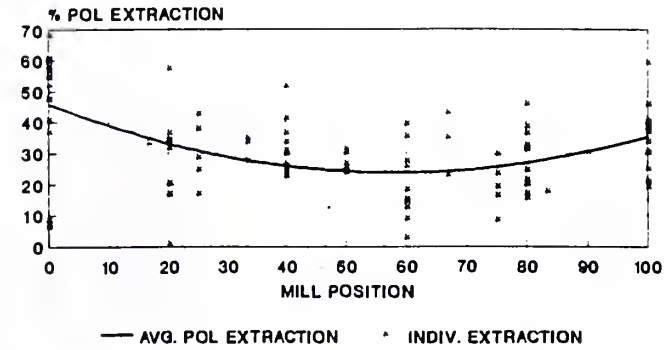
1994-95 CROP DATA

FIGURE 22.
LAST MILL POL EXTRACTION
VS FACTORY



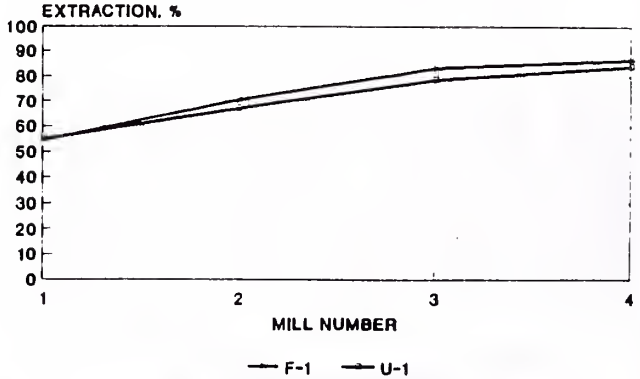
1994-95 CROP DATA

FIGURE 23.
INDIVIDUAL MILL POL EXTRACTION
VS MILL POSITION



0 = MILL 1
100 = LAST MILL
1994-95 CROP DATA

FIGURE 24.
CUMULATIVE POL EXTRACTION VS MILL NUMBER
4-MILL TANDEMS



1994-95 CROP DATA

FIGURE 25.
CUMULATIVE POL EXTRACTION VS MILL NUMBER
5-MILL TANDEMS

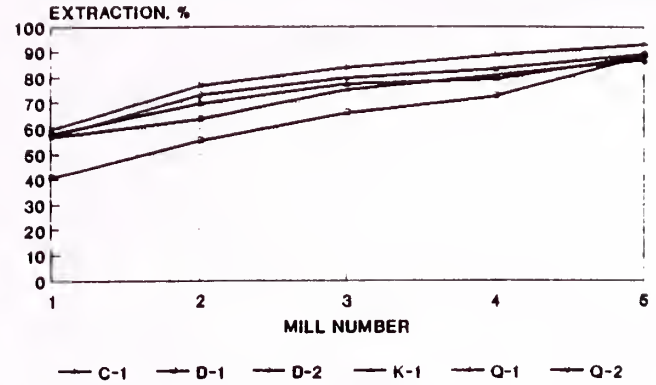


FIGURE 26.
CUMULATIVE POL EXTRACTION VS MILL NUMBER
6-MILL TANDEMS

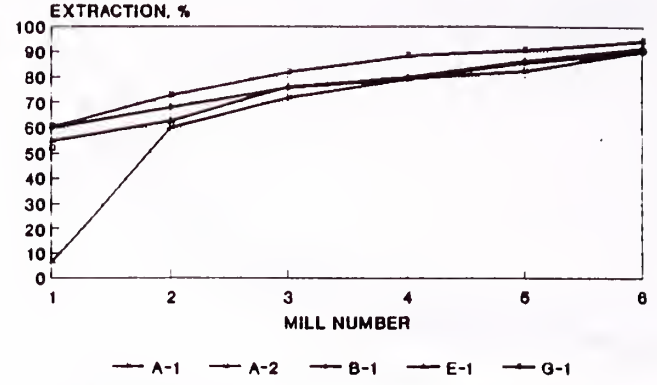


FIGURE 27.
CUMULATIVE POL EXTRACTION VS MILL NUMBER
6-MILL TANDEMS

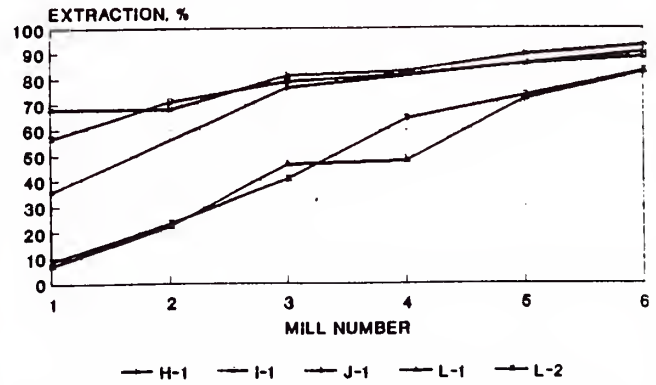


FIGURE 28.
CUMULATIVE POL EXTRACTION VS MILL NUMBER
6-MILL TANDEMS

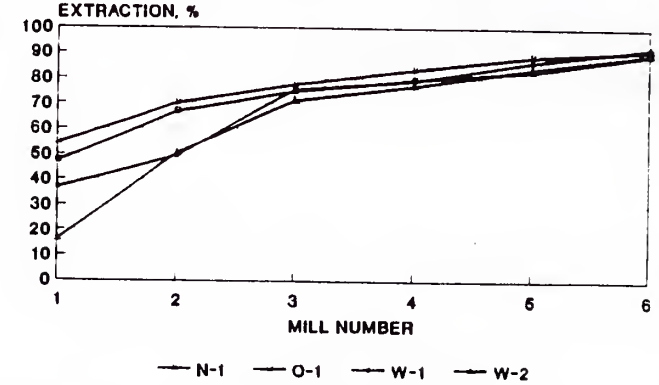
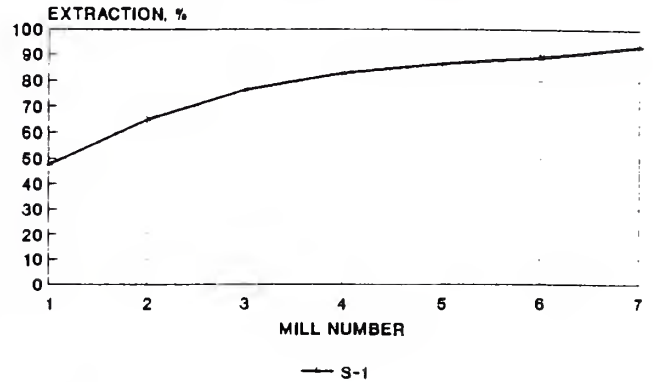
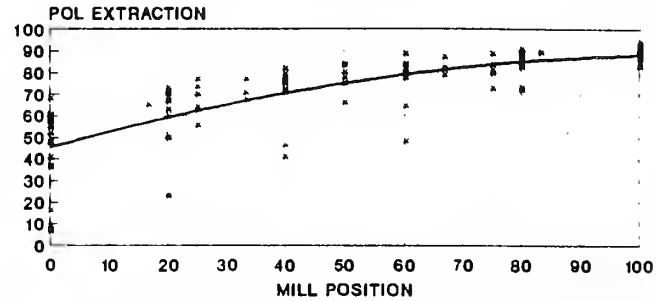


FIGURE 29.
CUMULATIVE POL EXTRACTION VS MILL NUMBER
7-MILL TANDEM



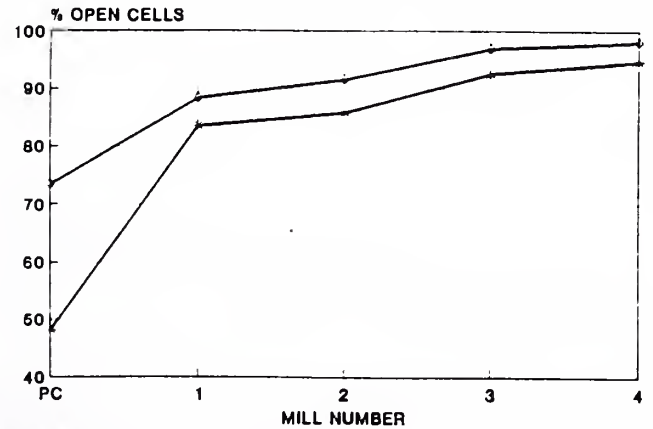
1994-95 CROP DATA

FIGURE 30.
CUMULATIVE POL EXTRACTION
VS MILL POSITION



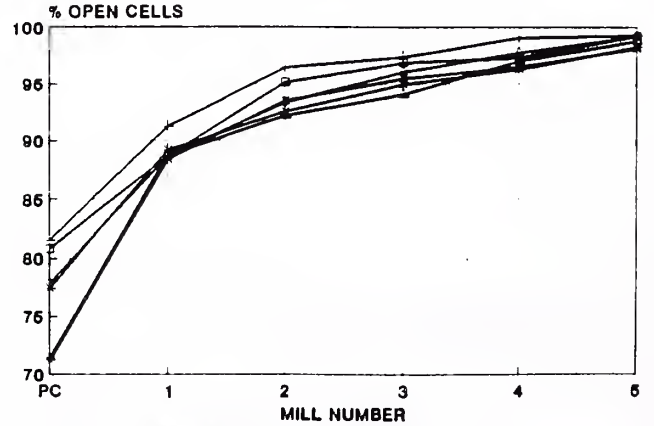
0 = MILL 1
100 = LAST MILL
1994-95 CROP DATA

FIGURE 31.
% OPEN CELLS THROUGHOUT 4-MILL TANDEMS



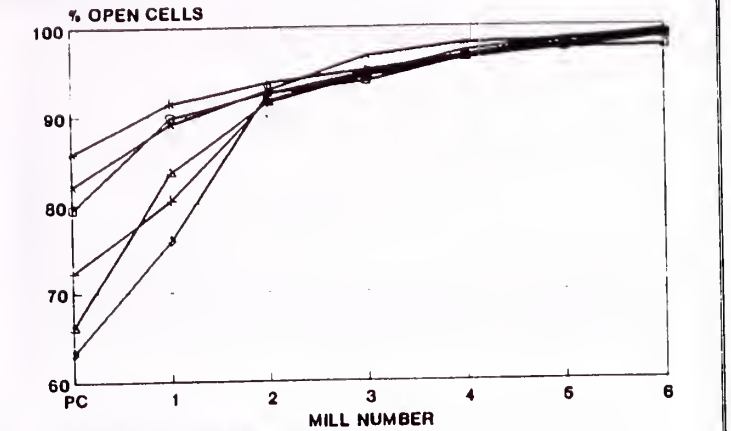
1994 CROP DATA

FIGURE 32.
% OPEN CELLS THROUGHOUT 5-MILL TANDEMS



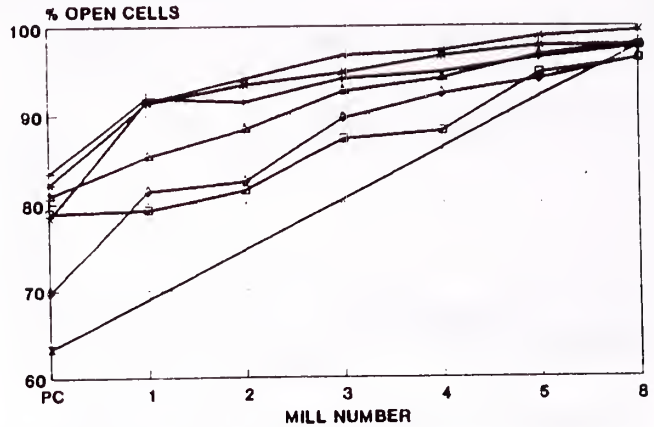
DATA FROM 1993 AND 1994 CROPS

FIGURE 33.
% OPEN CELLS THROUGHOUT 6-MILL TANDEMS



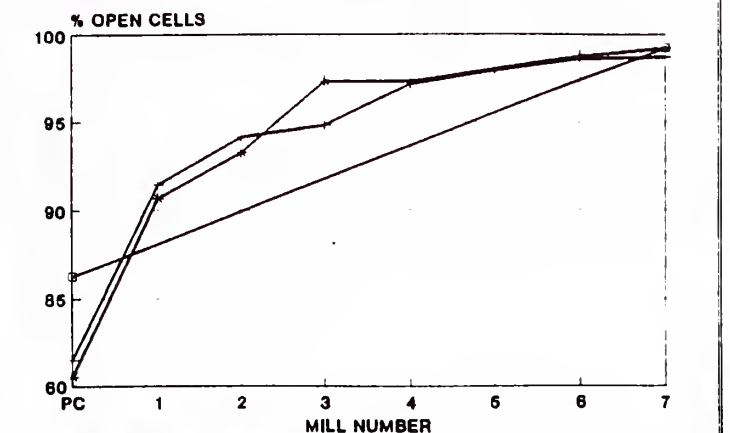
DATA FROM 1993 AND 1994 CROPS

FIGURE 34.
% OPEN CELLS THROUGHOUT 6-MILL TANDEMS



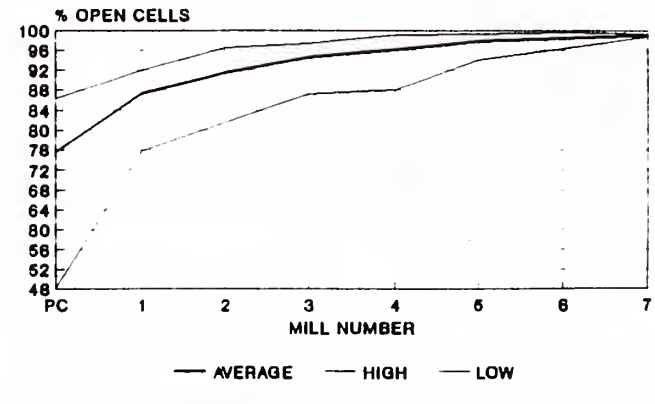
DATA FROM 1993 AND 1994 CROPS

FIGURE 35.
% OPEN CELLS THROUGHOUT 7-MILL TANDEMS



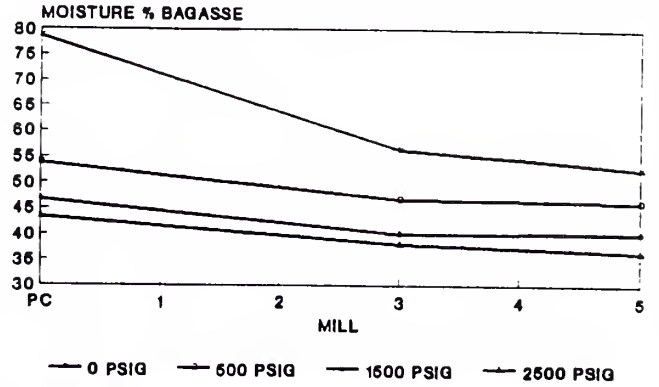
DATA FROM 1993 AND 1994 CROPS

FIGURE 36.
% OPEN CELLS THROUGHOUT MILL TANDEMS
AVERAGE, HIGH, & LOW



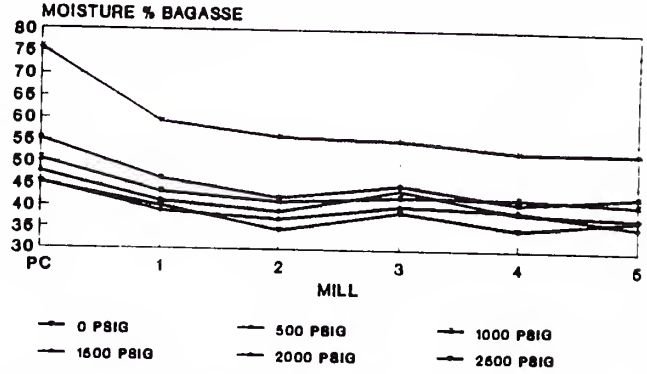
DATA FROM 1993 AND 1994 CROPS

FIGURE 37.
MOISTURE % BAGASSE VS HYDRAULIC PRESSURE



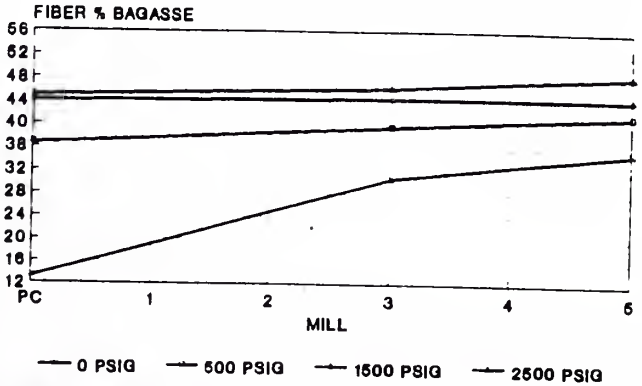
ST. JAMES 12/06/94.
ACTUAL PRESSURE ON BAGASSE 61.61% MORE
THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 38.
MOISTURE % BAGASSE VS HYDRAULIC PRESSURE



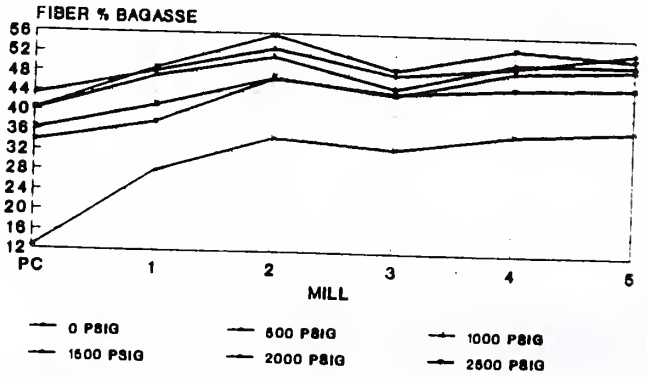
ST. JAMES 12/07/94-12/08/94.
ACTUAL PRESSURE ON BAGASSE 61.61% MORE
THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 39.
FIBER % BAGASSE VS HYDRAULIC PRESSURE



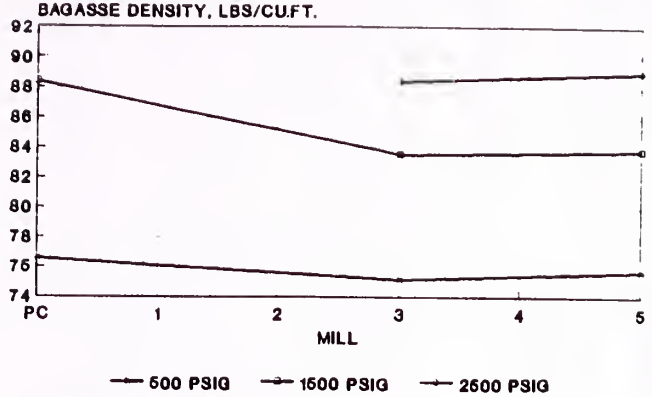
ST. JAMES 12/06/94.
ACTUAL PRESSURE ON BAGASSE 61.61% MORE
THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 40.
FIBER % BAGASSE VS HYDRAULIC PRESSURE



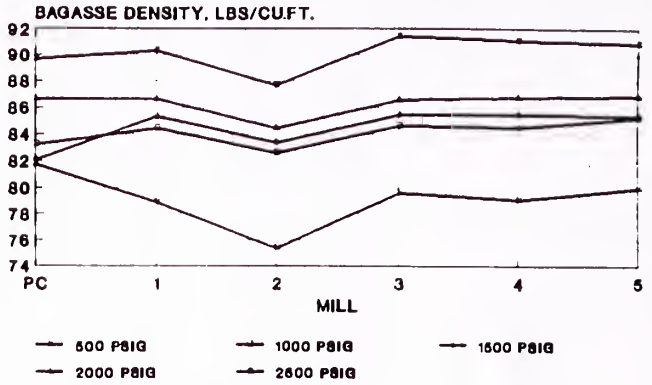
ST. JAMES 12/07/94-12/08/94.
ACTUAL PRESSURE ON BAGASSE 61.61% MORE
THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 41.
BAGASSE DENSITY VS HYDRAULIC PRESSURE



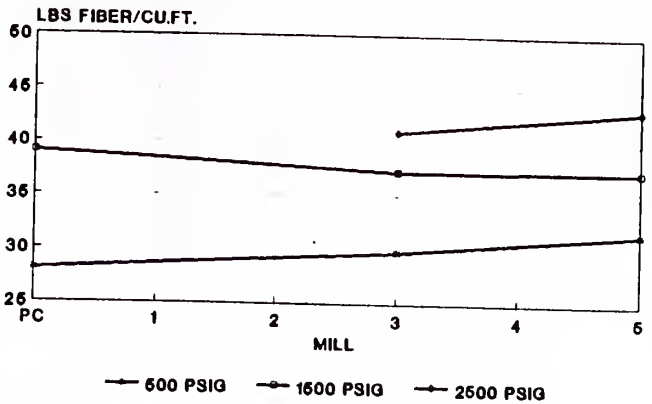
ACTUAL PRESSURE ON BAGASSE 51.51% MORE THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 42.
BAGASSE DENSITY VS HYDRAULIC PRESSURE



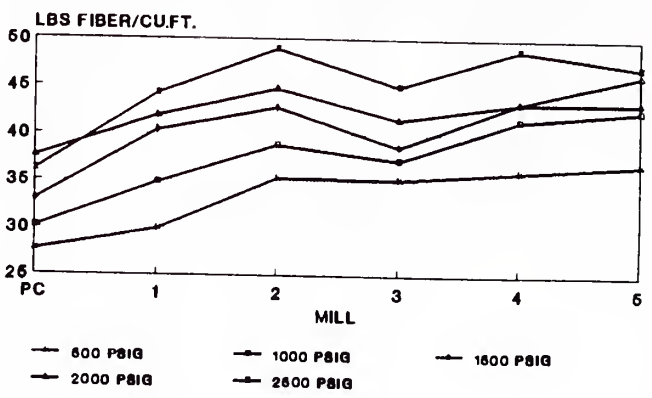
ACTUAL PRESSURE ON BAGASSE 51.51% MORE THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 43.
FIBER DENSITY VS HYDRAULIC PRESSURE



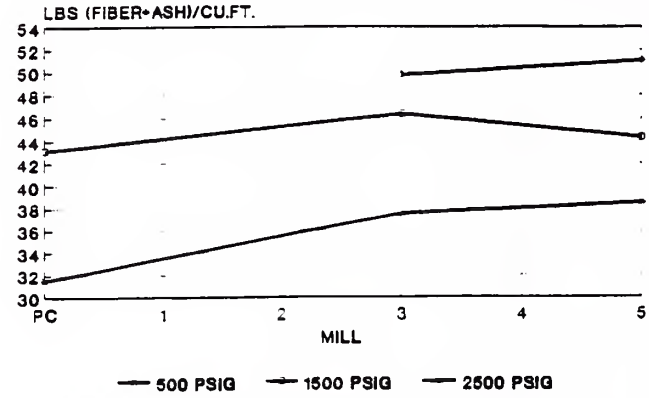
ACTUAL PRESSURE ON BAGASSE 51.51% MORE THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 44.
FIBER DENSITY VS HYDRAULIC PRESSURE



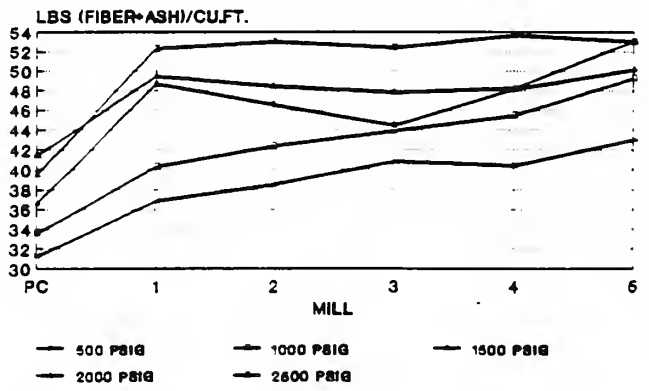
ACTUAL PRESSURE ON BAGASSE 51.51% MORE THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 45.
FIBER+ASH DENSITY VS HYDRAULIC PRESSURE



ACTUAL PRESSURE ON BAGASSE 61.61% MORE
THAN CORE LAB PRESS HYDRAULIC PRESSURE.

FIGURE 46.
FIBER+ASH DENSITY VS HYDRAULIC PRESSURE



ACTUAL PRESSURE ON BAGASSE 61.61% MORE
THAN CORE LAB PRESS HYDRAULIC PRESSURE.

TURBIDITY - RAW SUGAR, JUICE, AND SYRUP QUALITY

Stephen J. Clarke
Audubon Sugar Institute

ABSTRACT

The presence of fine suspended solids in sugar processing liquors is a major factor in determining process efficiency. Estimation of particle size by membrane filtration suggest that most turbidity causing materials are smaller than one micron. Turbidity measurements offer useful insights into process operations and the results of a program of study in this area are described.

The ICUMSA method for turbidity measurement involves determination of absorbed rather than scattered light. Nephelometers are now well developed and offer a superior measurement technique. The analytical methods are compared, taking into account the concentration of the continuous phase and the character of the dispersed phase. A simple and non-linear relationship between the nephelometric turbidity and the solution brix has been derived. This relationship appears to apply in all cases and suggests an optimum brix for measurement of turbidity of raw sugars and also a standard for expression of turbidity.

During this laboratory study and in measurements under various raw sugar factory conditions, the following observations were made and are discussed in the paper. The turbidity of juice leaving the clarifier was often higher than that of the feed after the mud is settled rapidly. Raw sugar factory syrup, when diluted to the same brix as the evaporator feed, often has a higher turbidity than the feed. Some raw sugar turbidities decrease with time, indicating a change in the dispersed phase and presenting measurement problems.

INTRODUCTION

Turbidity measurements are becoming more important as means to assess performance in sugar processing operations, but there has been relatively little study of the subject from a more basic standpoint as it applies to solutions with high dissolved solids content. The conventional method involves absorption measurements with a spectrophotometer at high wavelength where the color of the solution becomes less important. [1] The distinction between color and turbidity should be clearly understood, but the use of spectrophotometric techniques confuses the issue. [2] Spectrophotometers measure the quantity of radiation that does not reach the instrument detector, for whatever reason, by absorption or by light scattering. The geometry of spectrophotometers is such that they are unsuitable for reliable turbidity measurements. Nephelometers are designed to measure scattered light and are of quite different

geometries, but that is not the topic of this paper. High quality nephelometers are now commercially available (often cheaper than spectrophotometers), and they should be routinely used in sugar industry laboratories.

One of the questions that arises in turbidity measurement is the choice of materials for standardization of instruments. Formazin is routinely used, but there are also recommendations for the use of more rigorously defined materials, e.g., fine polystyrene beads with narrow size distribution. [3] Also, since the degree of light scattering is a function of the difference in refractive index between the continuous phase (solution) and the dispersed phase (suspended material), it is desirable to take into account the impact of dissolved solids (predominantly sucrose) on the measured turbidity.

The instruments used in this study were a Gilford spectrophotometer and a Hac extended range ratio turbidimeter. Instruments of different designs may be expected to give somewhat different results, and the material presented in this paper is intended to demonstrate some aspects of nephelometric measurements rather than provide a definitive method.

COMPARISON OF A SPECTROPHOTOMETER AND A NEPHELOMETER

Initial experiments were performed to compare the instruments responses to the same turbid materials. Figure 1 shows the results of using varying amounts of formazin suspensions in water and 20 brix sucrose solution in the spectrophotometer and the nephelometer. The nephelometric turbidity unit (NTU) is an arbitrary standard against which most nephelometers are calibrated. Although the numerical NTU value is much higher than the absorbance, this is merely a matter of convention and could be avoided by using milli-absorbance-units (absorbance x 1000).

Both solutions behave very similarly in their comparative responses but the relationship between NTU and absorbance is not linear, especially at higher values.

Figure 2 shows a similar comparison with two suspensions of fine polystyrene beads of different sizes. The smaller beads (0.196 micron diameter) show an almost linear relationship between NTU and absorbance, but this is far from the case with the larger beads (1.03 micron diameter). This result is consistent with the nature of light scattering and is important since most of the turbidity causing material is sugar processing streams is between these sizes. [4,5,6] Many more comparative measurements need to be made if spectrophotometric measurements continue to be used. However, it is preferable to pursue the use of the best available technology, nephelometry, and the remainder of the paper deals with its application to sugar containing liquors.

FIGURE 1

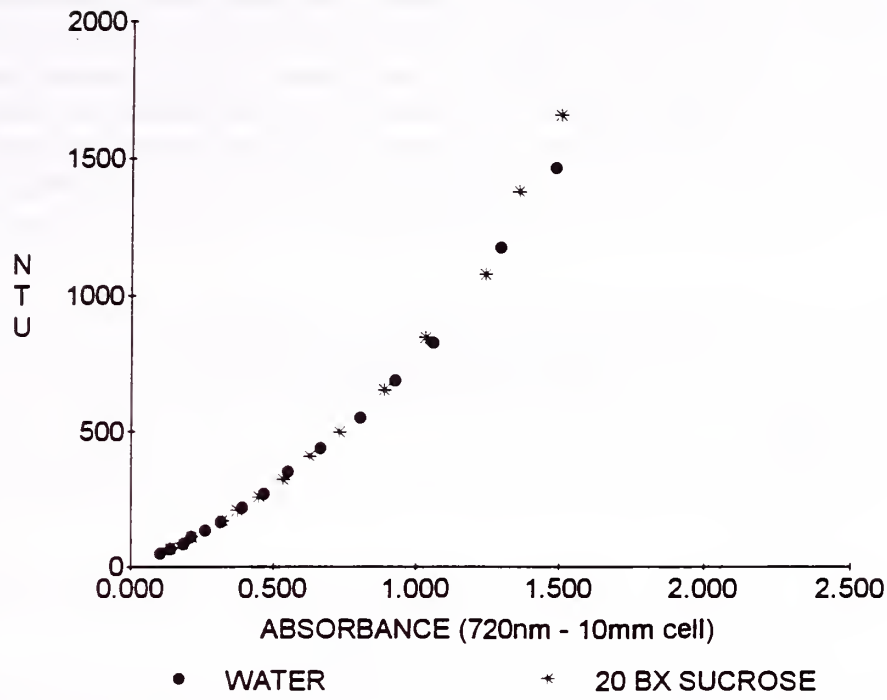
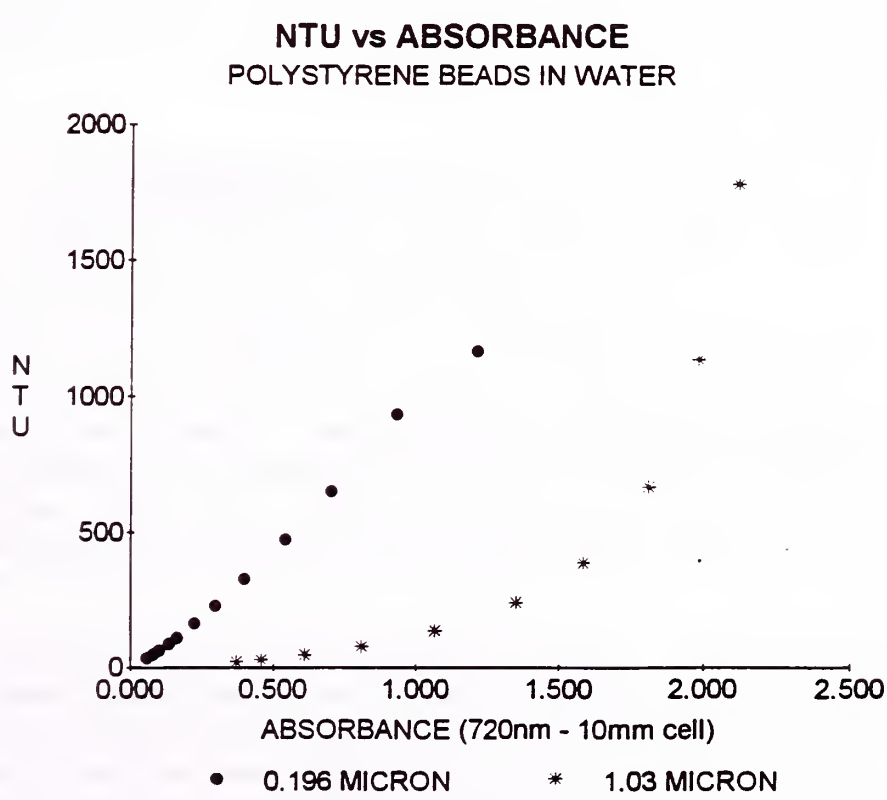


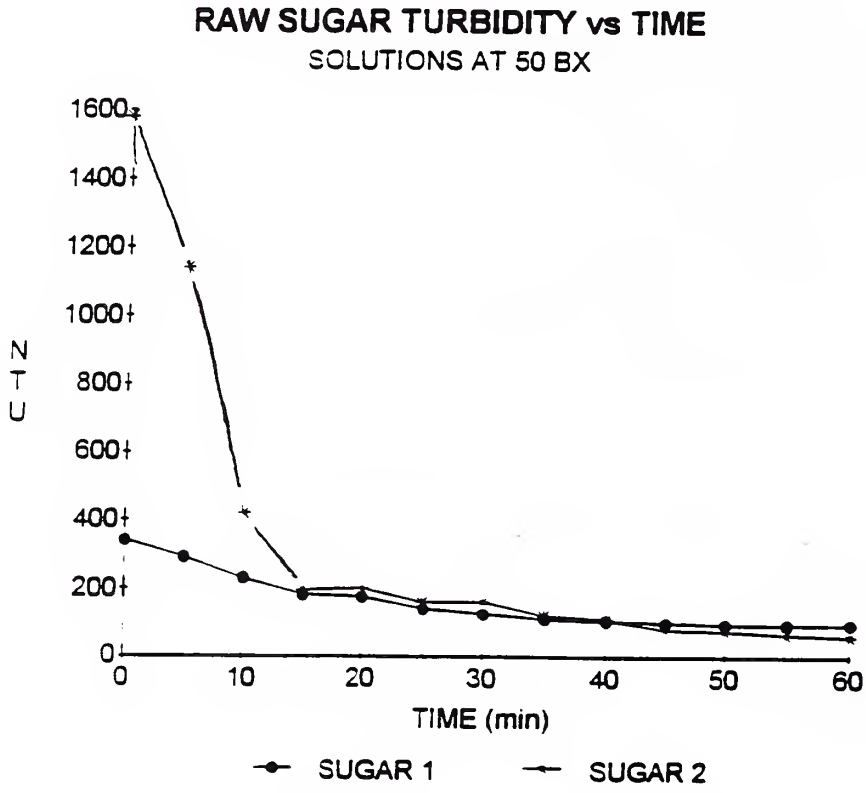
FIGURE 2



INDUSTRY USES OF NEPHELOMETRY

Measurements of turbidity in process streams has become fairly common, e.g., in the evaluation of clarifier performance in the raw sugar factory, the evaluation of raw sugar quality and in the evaluation of filter performance. [7] The choice of brix at which the measurement is to be made is important, especially if significant dilution is involved in sample preparation. This is dealt with in more detail in the following section. Figure 3 illustrates one of the problems in determining the turbidity of a raw sugar solution.

FIGURE 3



Both samples were dissolved in water to 50 brix, degassed under vacuum, and placed into the nephelometer. The time interval between starting to dissolve the sugar and starting the measurements was less than 5 minutes. The NTU reading did not stabilize until after about 40 minutes, the decrease being much more marked for Sugar 2 than for Sugar 1.

The same results were obtained upon repetition of the measurement and the turbidity did not increase if the sample was removed and shaken to resuspend any settled and/or coagulated solids. The conclusion is that some of the turbidity-causing material dissolved upon standing, much more so for sample 2. If the suspended solids had become more dispersed into finer particles, this would normally result in an increase in turbidity. These results suggest that a waiting time should be specified for these measurements.

Rapidly settled clarified juice usually has a lower turbidity (by 10 to 30%) than that which has been in the clarifier for an extended time. Samples of clarifier feed (including flocculant) were taken and settled in a beaker inside the clarifier overflow (to maintain temperature) and compared with the regular clarified juice. These juices were screened to remove particles greater than 50 micron (mainly bagacillo) before turbidity measurements. The opalescence (to the eye) of the regular clarified juice was significantly higher than the quickly settled juice, consistent with the increased turbidity. In most raw factory operations good clarification is considered to be absence of large particles of bagacillo or floc, and the background turbidity is ignored.

In a study of the comparison of syrup turbidity and clarified juice turbidity, in order to obtain comparable results (i.e., the dissolved solids and therefore refractive index of the continuous phase being the same) it was necessary to dilute the syrup to the same brix as the clarified juice. In all cases, the syrup of increased precipitation of insoluble material during evaporation. It would be interesting to determine whether such an increase in turbidity correlates at all with the level of evaporator scaling.

RELATIONSHIP BETWEEN NTU AND BRIX

In the measurement of the turbidity of syrup after dilution it was found that the turbidity (NTU) of the liquor was not linear with brix. Initially the NTU value increased until the brix reached about 35 and then decreased (Figure 4). This result was found with any sugar solution at this brix, whether from process or made in the laboratory. Examples of the latter are suspensions of formazin, alumina, or silica in 65 brix sucrose solution.

It is perhaps unreasonable to expect a relationship between turbidity (NTU) and brix, but all the brix measurements were made refractometrically, and the relationship is better considered to be between NTU and refractive index. The brix data used for Figure 4 were converted to refractive index and are shown in Figure 5. A qualitative explanation for the shape of these curves is that, at the higher brix values, the decrease in refractive index upon dilution has a greater impact upon the light scattering than does the decrease in particle concentration. Once the maximum is passed, then the dilution effect predominates. Similar results were obtained using a suspension of silica in dimethyl sulfoxide (which has a high apparent brix) and diluting this with water.

It is common practice to express the turbidity in terms of its ratio to the brix and to make these measurements at low brix values (< 10) where the relationship between NTU and brix is assumed to be linear. Evaluation of all of our data shows this not to be the case, and typical results of plotting NTU/brix against brix are given in tables 1 and 2. The r^2 data given in Table 1 are for the relationships illustrated in Figure 6. The linear correlation is good between NTU/brix and brix, and this can be used to derive an empirical relationship, as shown in Table 2.

The brix value for extrapolation of the line to a zero value for NTU/brix

FIGURE 4

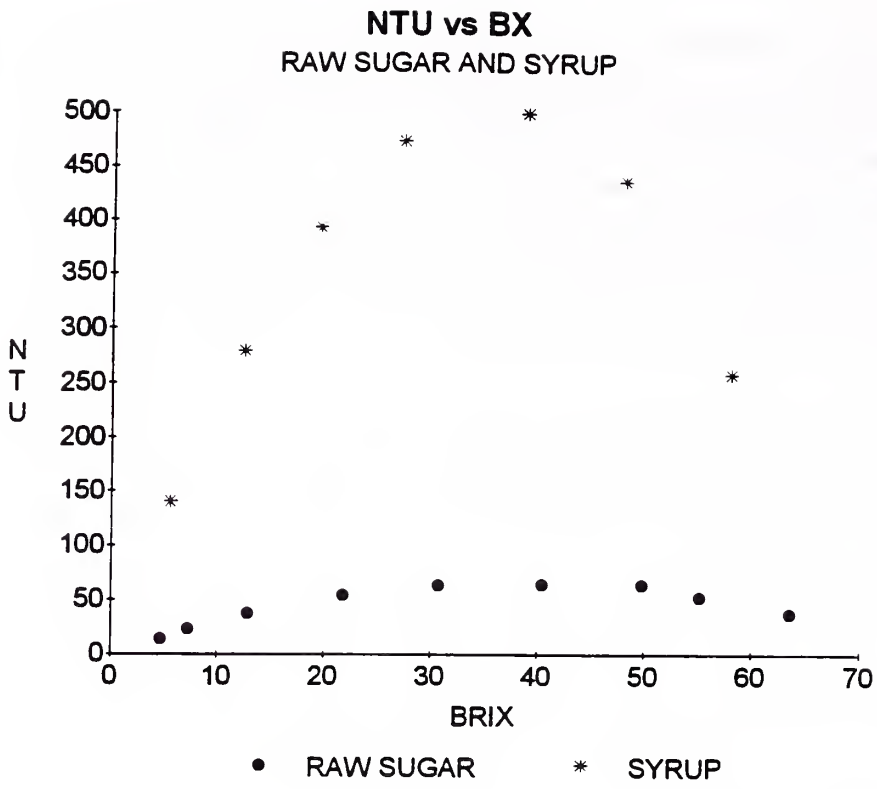
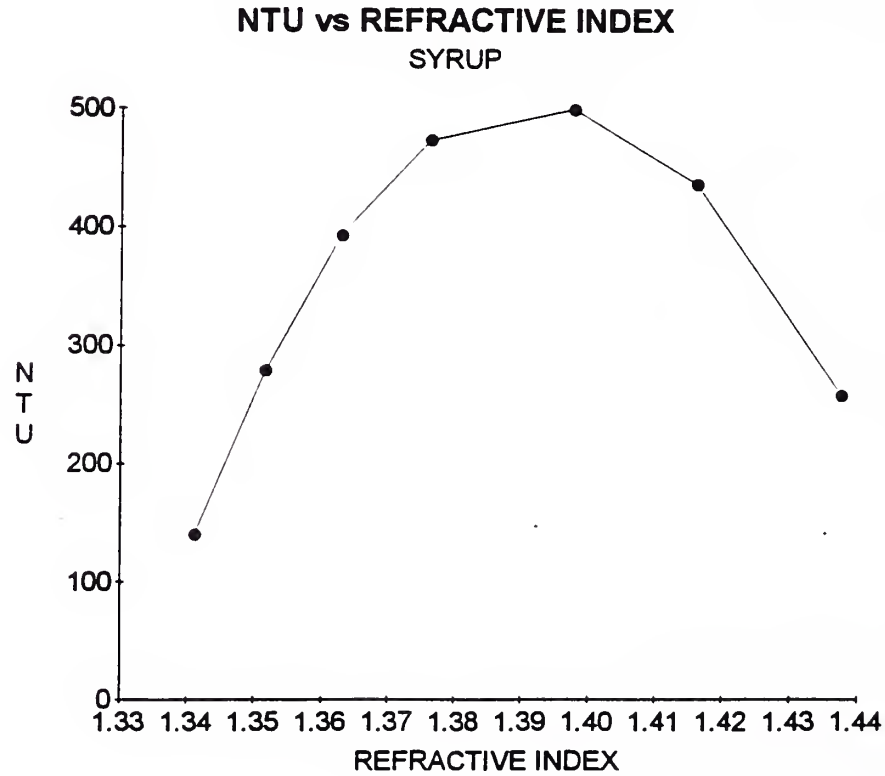


FIGURE 5



may be construed as that at which the refractive index of the solution would equal that of the suspended material. This could explain some of the variations in the values for a as shown in Table 1.

The data fit a parabolic equation, and the maximum value for NTU as a function of brix can be derived by differentiation of this equation (Table 2). The data to date strongly suggest that the same value for a (71.6) is used in the equation and if m is determined from the slope of the line (Figure 6), then it is possible to reconstruct the turbidity at any brix (Figure 7). The match between the experimental and calculated values is quite good, the difference being probably due to the value for a for this sample being different from the average value used.

The advantage of being able to determine a value for m, perhaps without dilution, and using this to express a turbidity value for the material, could have significant advantages. Assuming a constant value for a, the turbidity could be calculated with acceptable accuracy for any reasonable brix value. Given the inherent inaccuracies in these measurements, this approach would be at least as good as any other. Measurement of turbidity at brix values between 30 and 40 would be preferred since the values are highest in this range.

FIGURE 6

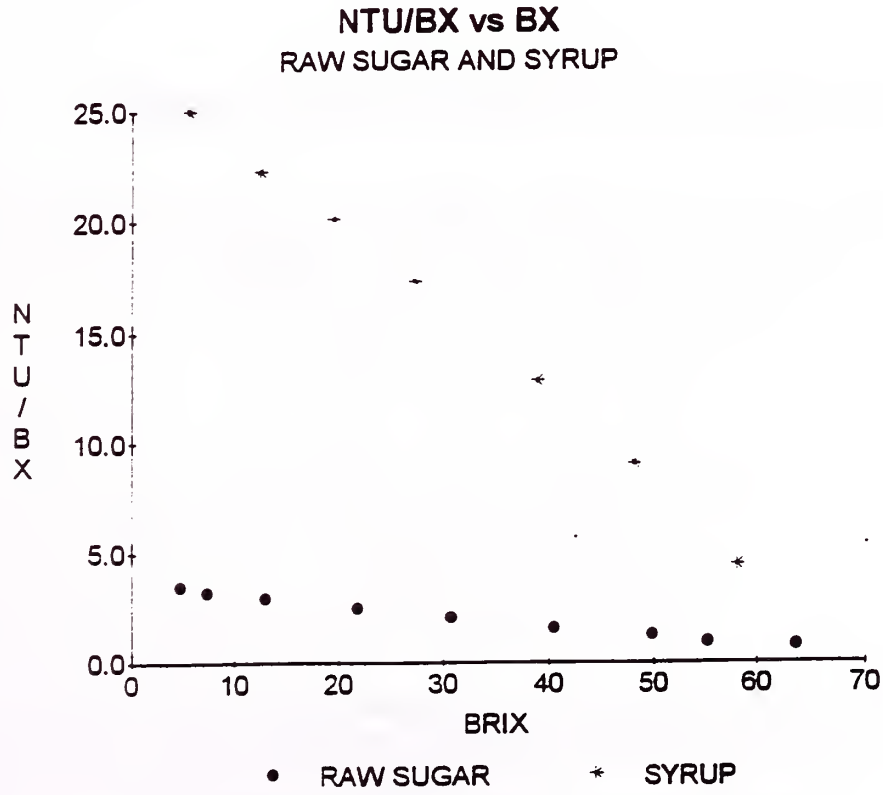


TABLE 1 NUMERICAL RELATIONSHIP BETWEEN NTU AND BRIX

$$NTU = m(a.Bx - Bx.Bx)$$

Sample	r sqd	m	a	Bx at max. NTU
Raw sugar	0.989	0.0509	76.3	38.2
Raw sugar	0.994	0.1869	73.6	36.8
Raw sugar	0.995	0.0909	68.5	34.3
Raw sugar	0.998	0.1118	67.4	33.7
Raw sugar	0.991	0.0390	73.0	36.5
Raw sugar	0.935	0.0280	68.5	34.3
Raw sugar	0.974	0.0245	69.6	34.8
Raw sugar	0.995	0.0335	77.7	38.9
Syrup	0.999	0.1869	73.6	36.8
Syrup	0.991	0.3336	68.9	34.5
Syrup	0.995	0.3865	71.1	35.6
			Mean	35.8
			Std. dev.	1.6

TABLE 2 DERIVATION OF RELATIONSHIP BETWEEN NTU AND BRIX

$$NTU/Bx = k.Bx + c$$

$$NTU = k.Bx^2 + c.Bx = k(Bx^2 + c.Bx/k)$$

k is negative and if $m = -k$ and $a = -c/k$

then $NTU = m(a.Bx - Bx^2)$

Also $d(NTU)/d(Bx) = m.a - 2m.Bx = 0$

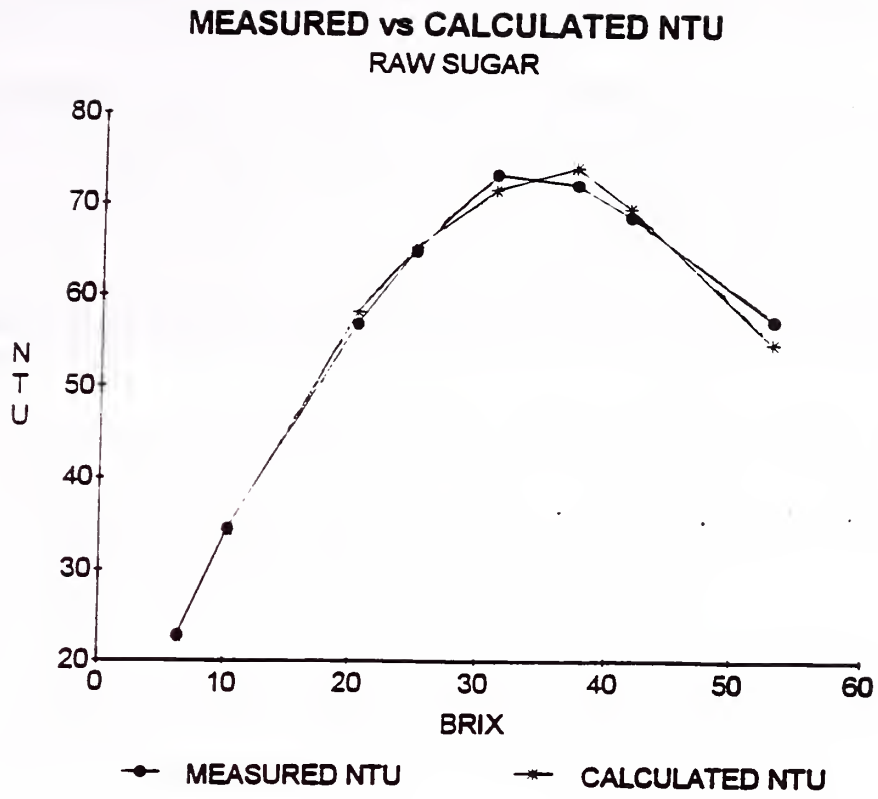
at maximum NTU value;

Bx for maximum NTU = a/2

If **a** is constant, as the data suggests,
then the variable that determines the turbidity is **m**.

Can **m** be used as a means to express turbidity?

FIGURE 7



SUMMARY

Advantages and complications of nephelometric turbidity determinations for sugar processing liquors are described. A tentative proposal is made for a method of expressing turbidity which would allow calculation of the expected turbidity at any brix value.

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DEXTRAN SURVEY 1994

Durriya Sarkar
Audubon Sugar Institute

Since 1986 Louisiana Sugar Mills have been reporting daily dextran data on sugar analyzed by the Haze method. Average sugar dextran values are calculated. Also data obtained for each sugar mill for the past nine years are plotted for an overall view. Dextran data on juice samples (core, crusher and dilute) done by the ASI II method were also received from Iberia Sugar Cooperative.

Figure 1. Plot for the daily average dextran in sugar for all Louisiana sugar mills taking part in the survey. The dextran was above penalty level 250 MAU (marked on the graph) for three periods, days 5 - 7, 11 - 14, 23 - 27, and on day 41. This year the temperatures stayed high in the initial half of the season. We found high levels of dextran following rainfall during this part of the season.

Figure 2. The daily average rainfall in inches for the season. The rainfall in the latter half of the season was accompanied by low temperatures for the days that were below 50°F and as we have noticed in the past, that under such conditions dextran was not a problem.

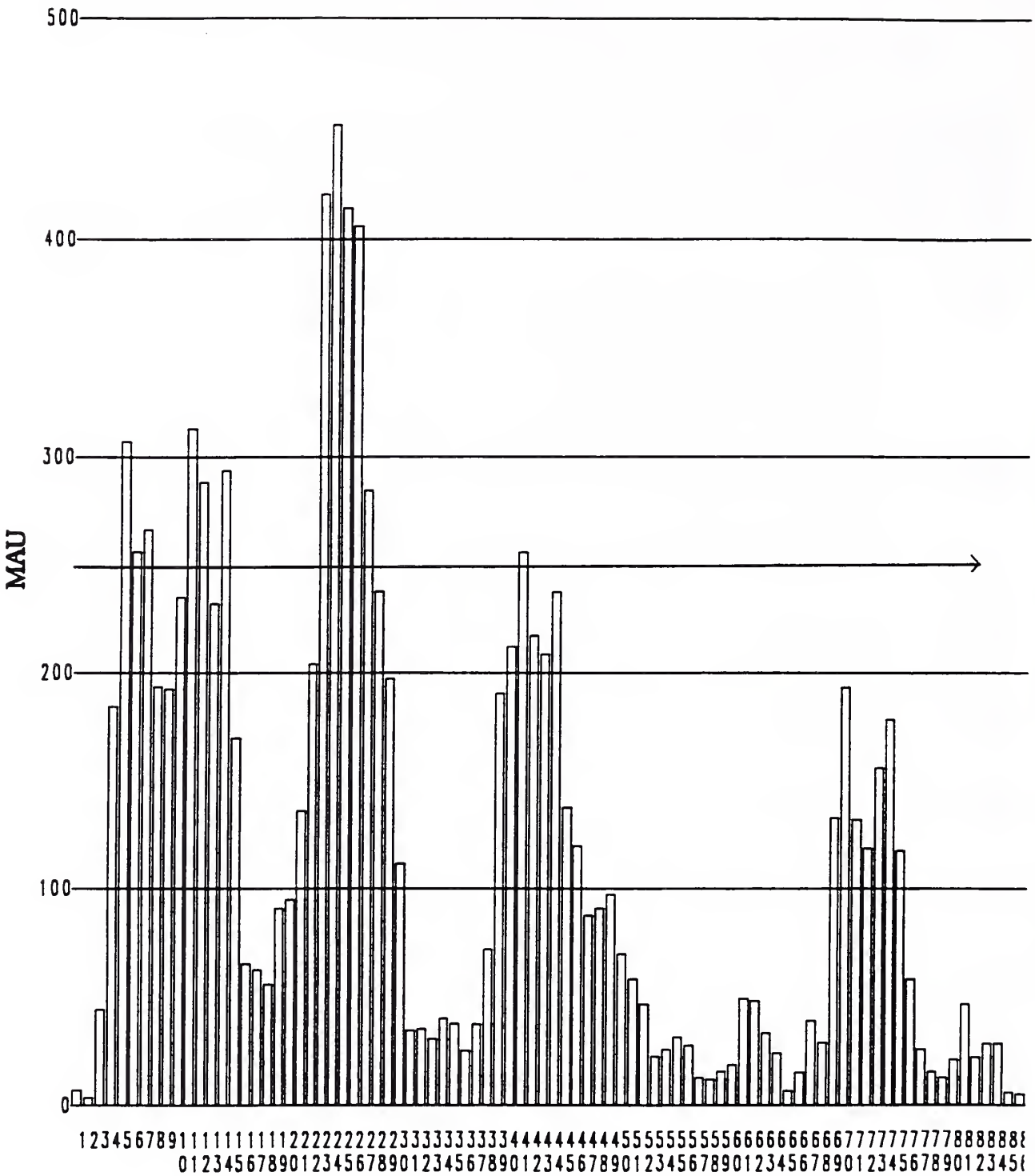
Figure 3. Average high and low temperatures recorded for the season showing consistently high temperatures for about 50 days.

Figure 4. Average dextran in sugar for the mills in the Teche region. The plot is almost synchronous with the average dextran plot (Figure 1).

Figure 5. Average dextran in sugar for the mills in the Bayou Lafourche area. Mills in this area had a shorter grinding season.

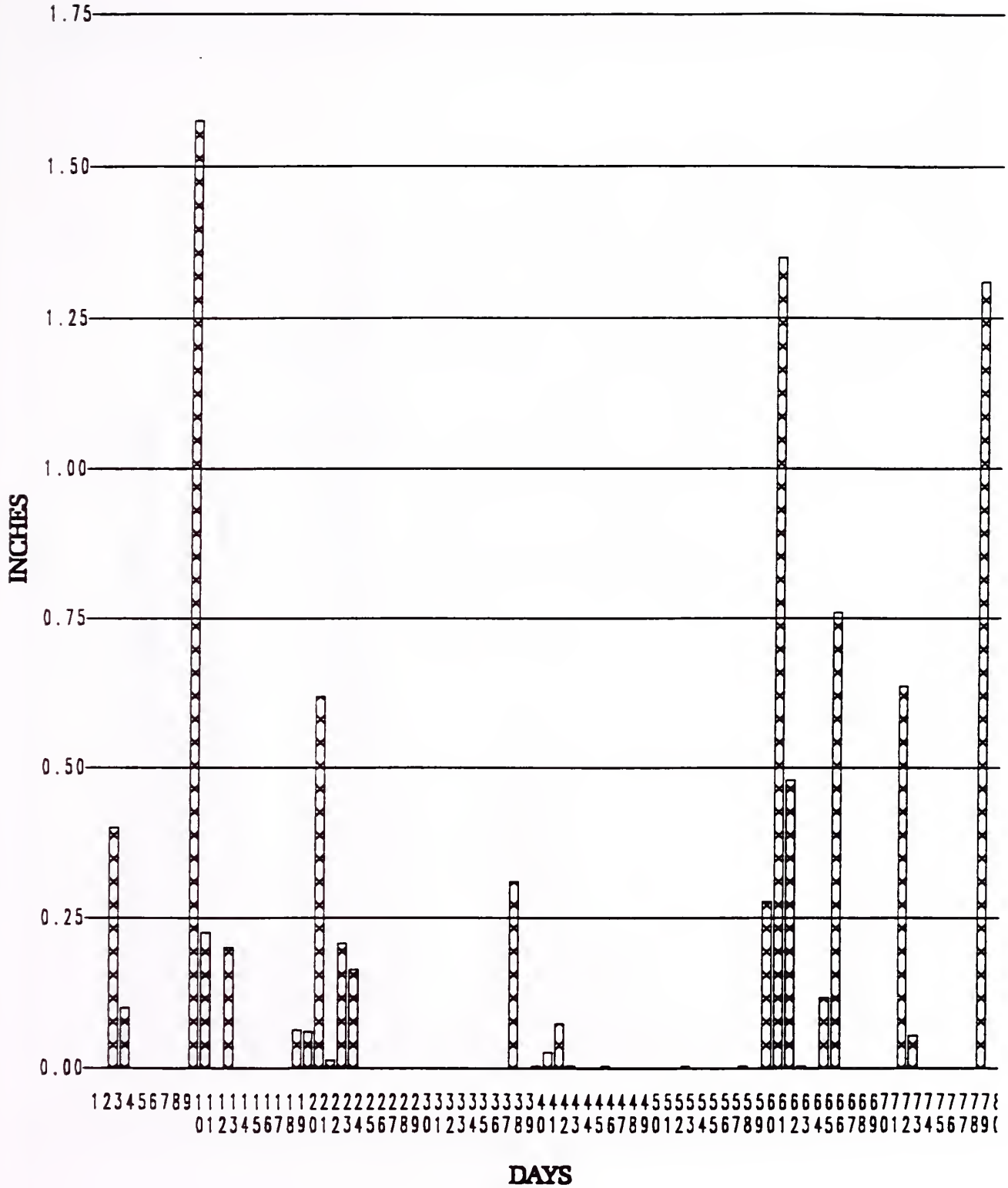
Figure 6. Average dextran in sugar for the mills in the Mississippi area. This plot shows several periods with dextran above the penalty level.

Figure 7. A bar graph showing the number of days above penalty level for sugar dextran for the 1994 season for each of the mills participating in the survey.



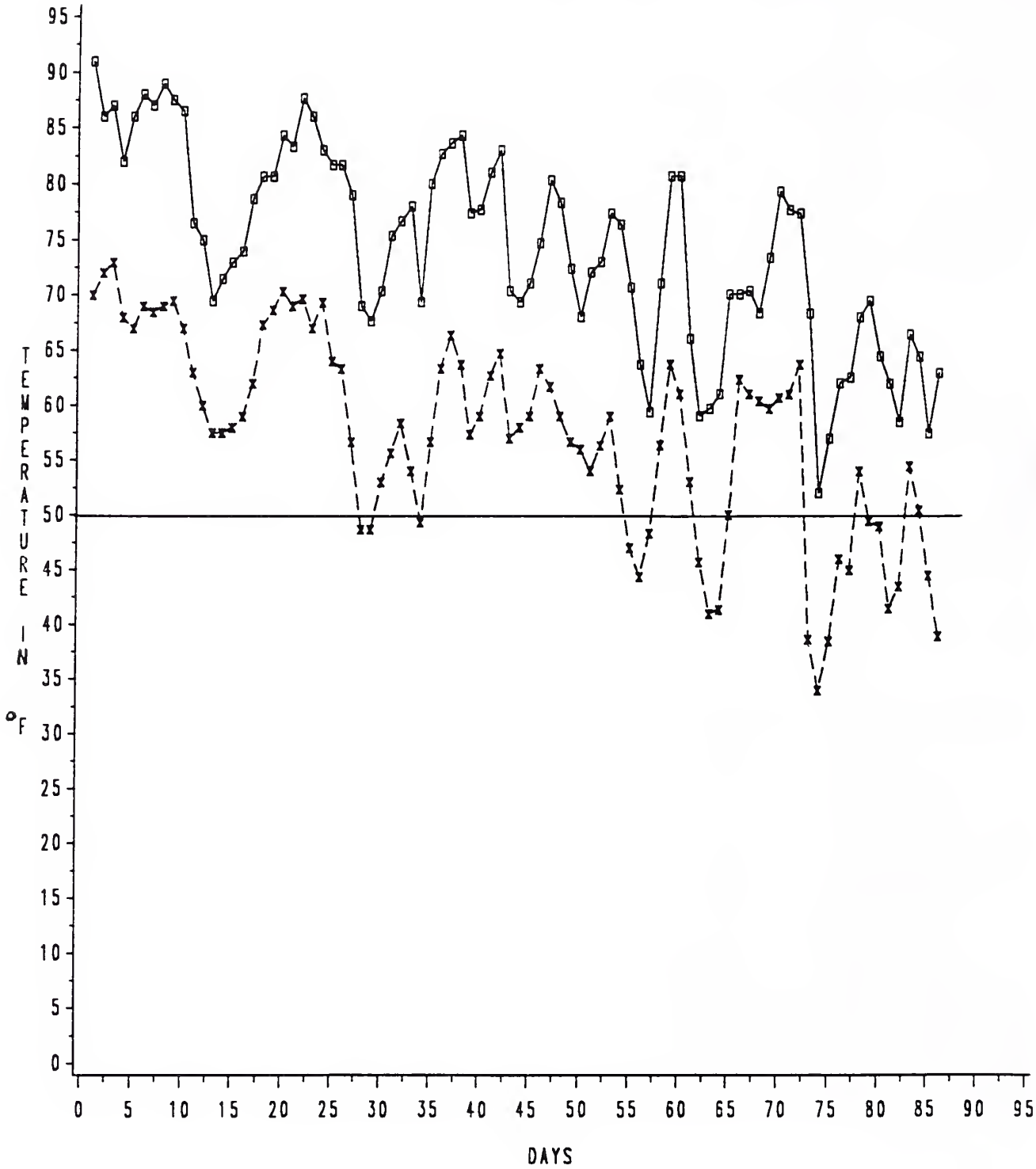
DAY 1 CORRESPONDS TO SEPTEMBER 29, 1994

FIGURE 1: AVERAGE SUGAR DEXTRAN, 1994 SEASON



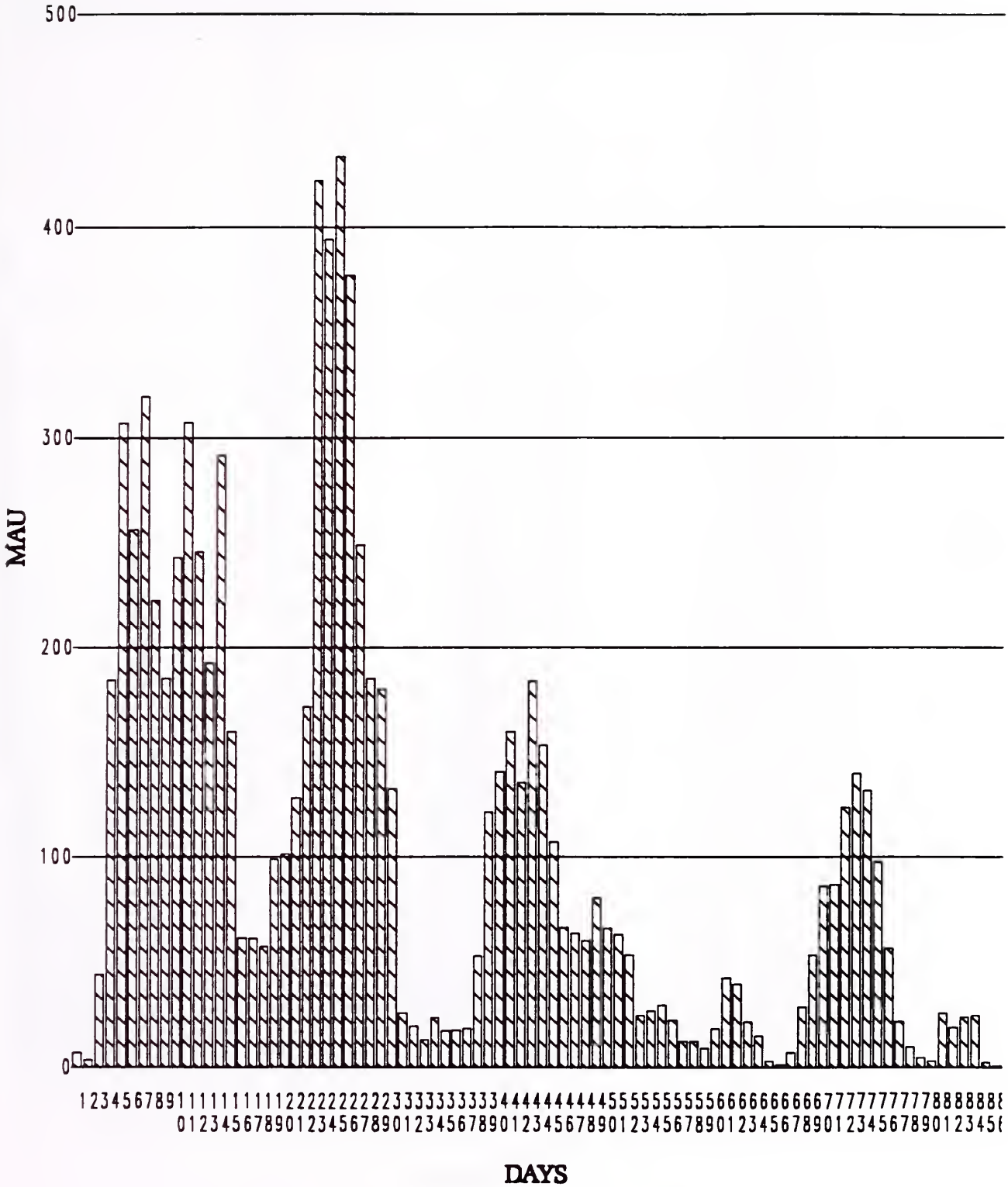
DAY 1 CORRESPONDS TO SEPTEMBER 29, 1994

FIGURE 2: AVERAGE RAINFALL FOR 1994 SEASON



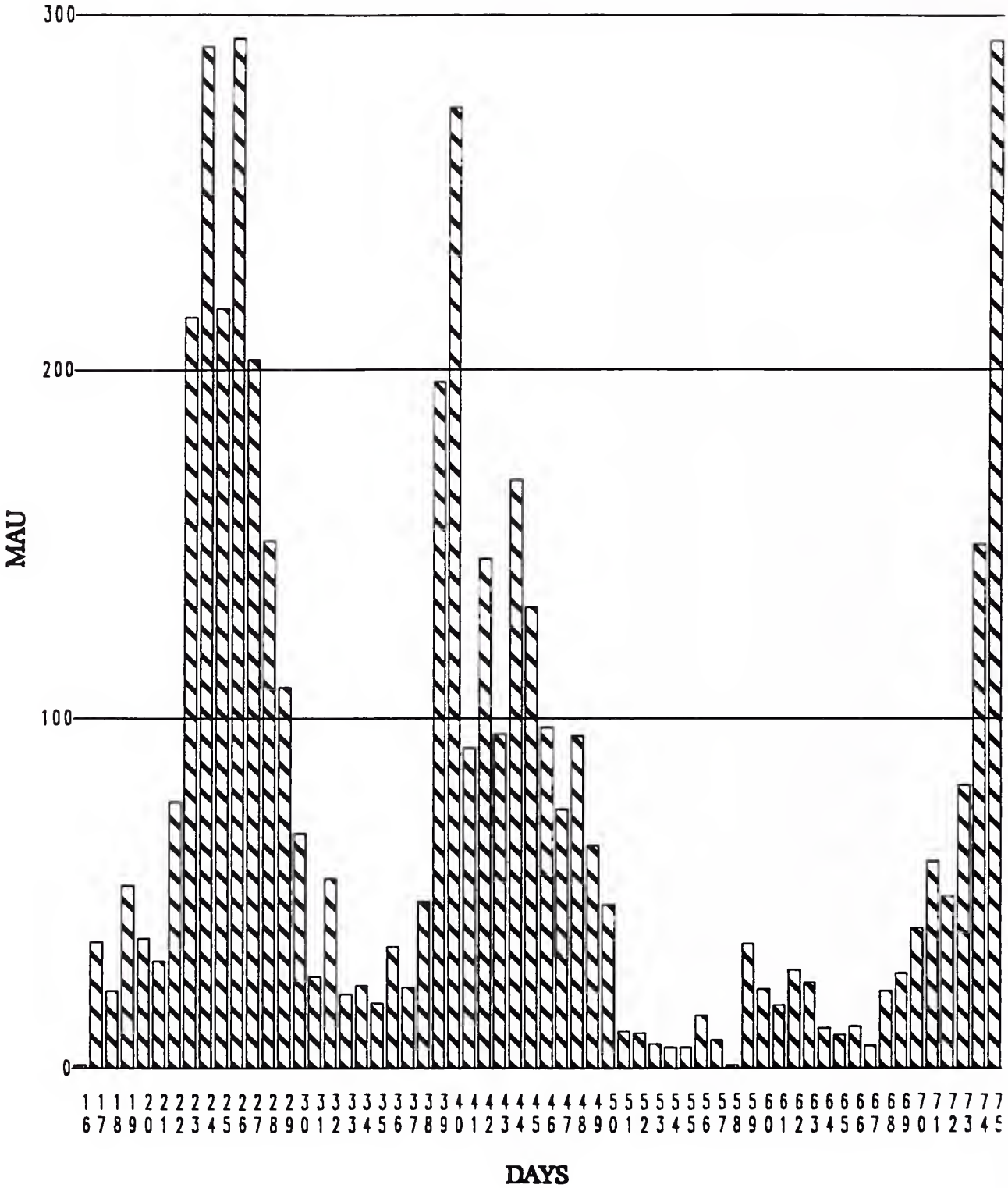
DAY 1 CORRESPONDS TO SEPTEMBER 29, 1994

FIGURE 3: AVERAGE HIGH AND LOW TEMPERATURE FOR 1994



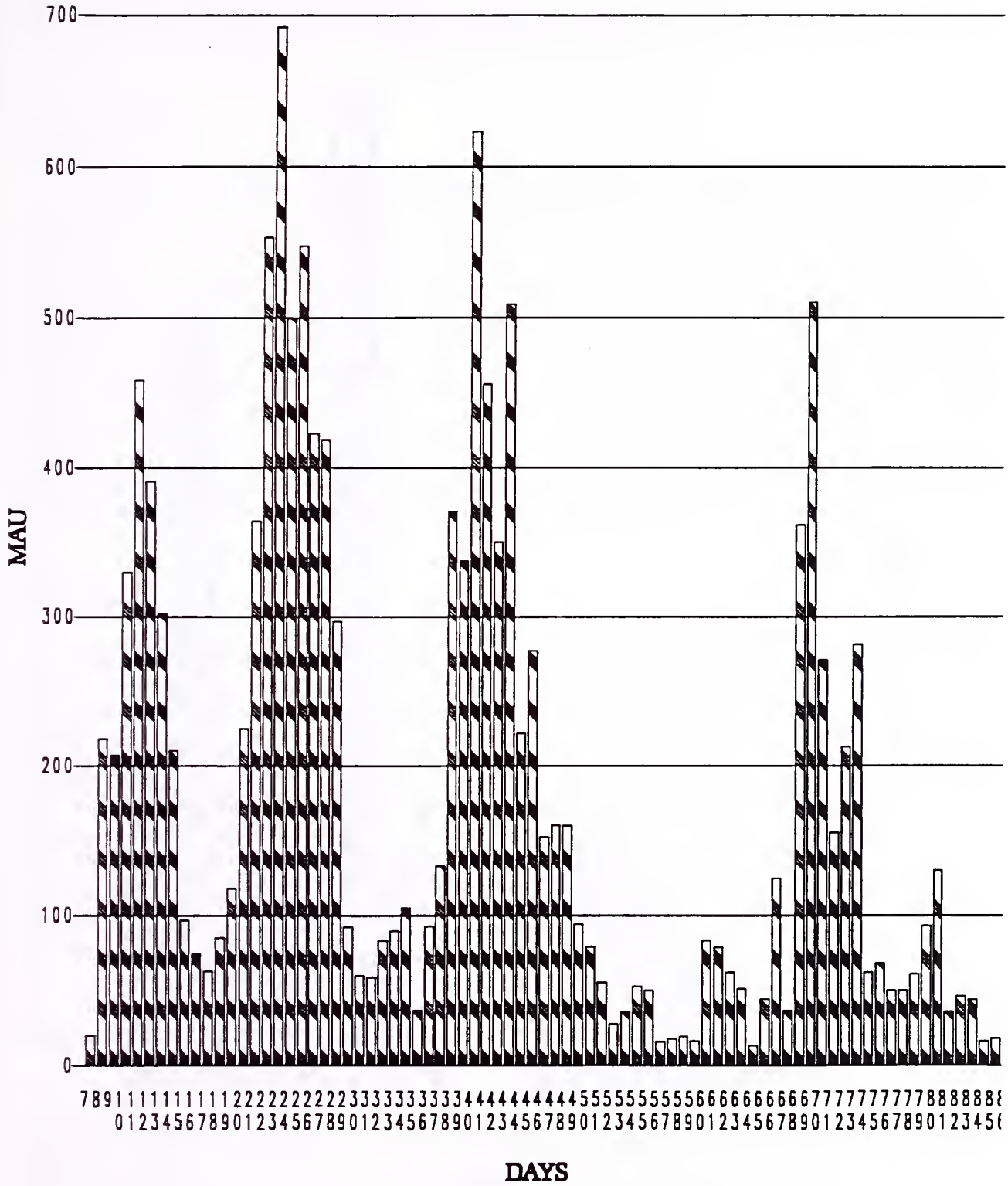
DAY 1 CORRESPONDS TO SEPTEMBER 29, 1994

FIGURE 4: AVERAGE SUGAR DEXTRAN, TECHE REGION



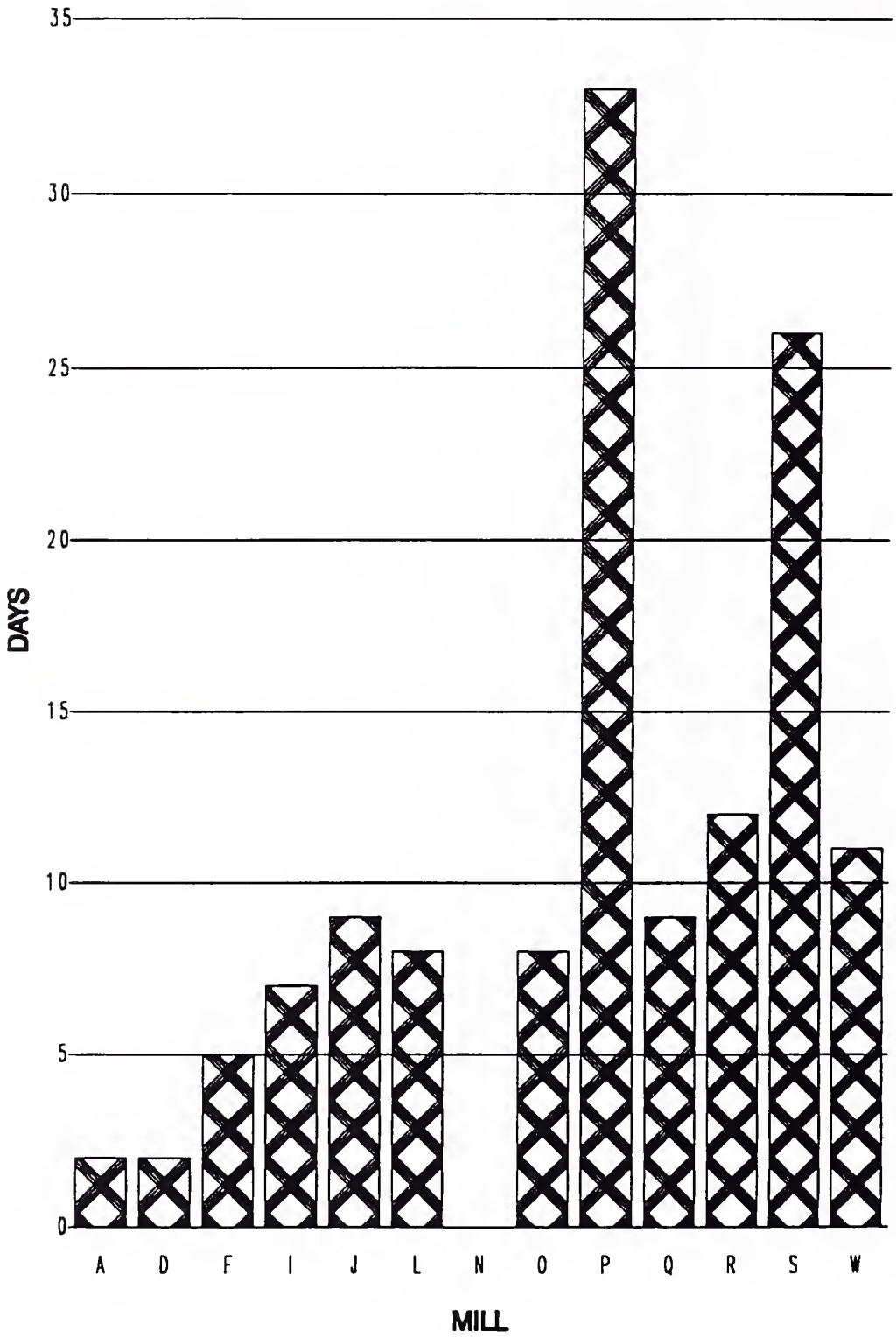
DAY 1 CORRESPONDS TO SEPTEMBER 29, 1994

FIGURE 5: AVERAGE SUGAR DEXTRAN, BAYOU REGION



DAY 1 CORRESPONDS TO SEPTEMBER 29, 1994

FIGURE 6: AVERAGE SUGAR DEXTRAN, MISSISSIPI REGION



LOUISIANA SUGAR MILLS, 1994 SEASON

FIGURE 7: DAYS ABOVE PENALTY LEVEL

COLOR FORMATION IN LOUISIANA SUGAR MILLS

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INTRODUCTION

Colorants in sugar process streams are classified into those that are of plant origin and those that are process generated. Color contributing compounds that originate in the plant include flavonoids, phenolics, amines, and amino acids. Process- derived colorants are generally polymeric, heat and metal catalyzed reaction products of these compounds (2). Colorants of plant origin are normally of a size less than 5,000 molecular weight. Process- generated colorants consist of the caramels, melanoidins, and alkaline degradation products of fructose. The caramels are thermal degradation products of sucrose and show increasing size with time and temperature. The meloidins and a high molecular weight sub-class, the melanins are Maillard reaction products of amine-containing compounds derived from the plant (1). Over the 1993-4 sugar processing seasons an investigation was undertaken as to the relative impact of processing on the color generation in process streams at Louisiana Sugar Mills.

METHODS

Representative samples (500 ml) were collected from various process streams in eight Louisiana sugar mills over a two year period. Samples were stored frozen (-20°C) until processed. Processing involved diluting thawed samples to a constant Brix (10.0) and adjusting the pH to 7.0 with the addition of NaOH or HCL as appropriate. Each sample was then clarified by centrifugation at 10,000 x g for 10 minutes. Clarified supernatants were sequentially filtered through a sequence of ultra-filters (Amicon Corp., Beverly, Mass.) with nominal cut-off values of 100,000, 50,000, and 5,000 molecular weights. The absorbance at 420 nm was determined on each ultra-filtrate using a Gilford Response spectrophotometer (Gilford Instruments, Oberlein, Ohio) and the absorbencies mathematically converted to the ICUMSA values, using the recommended standard of a 20 Brix solution (ICUMSA, 1994).

RESULTS AND DISCUSSION

A survey of average color values, on a Brix basis, for process streams from eight Louisiana sugar mills is shown in Figure 1. The percent changes in color with process stage are shown in Figure 2. The color of the process streams averaged about 4000 ICUMSA units/Brix through the evaporation stage. An increase to 6500 units was seen in the A molasses and a further increase to 8000 units in the B molasses.

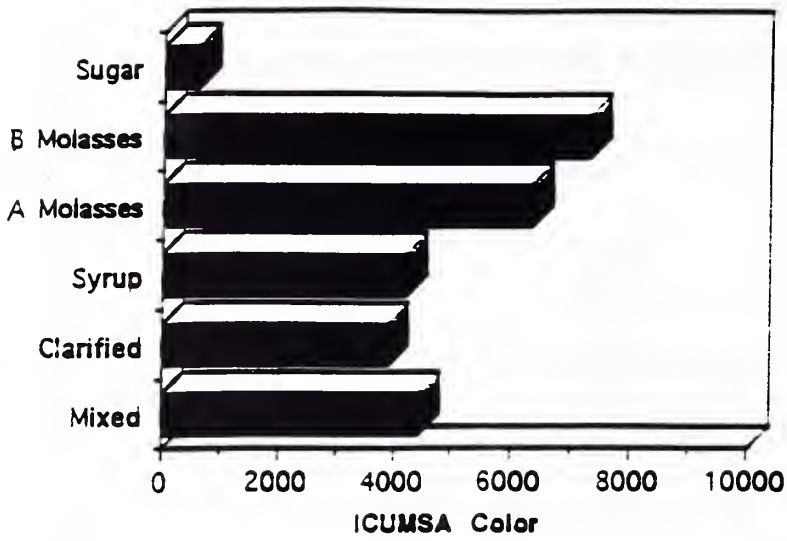

Figure 1. Average color values for process streams in eight Louisiana sugar mills. Values are given as ICUMSA units/Brix.

There was a 13% drop in color upon clarification (figure 2). This color was essentially regained upon evaporation. On average there was a 43% gain in color on the first strike and a further 20% increase on the second strike. As these numbers are not balanced for mass loss due to sugar removal conclusions should not be drawn as to whether this a "true" color increase or an artifact of the method. Sugar had about 12% of the original color of the mixed juice on a solids basis. No conclusion can be drawn as to what proportion of the color retained in the sugar is process generated and what proportion came in with the cane plant; however, Clarke *et al.* (1) has reported that the high molecular weight colorants are preferentially occluded in the sugar crystals.

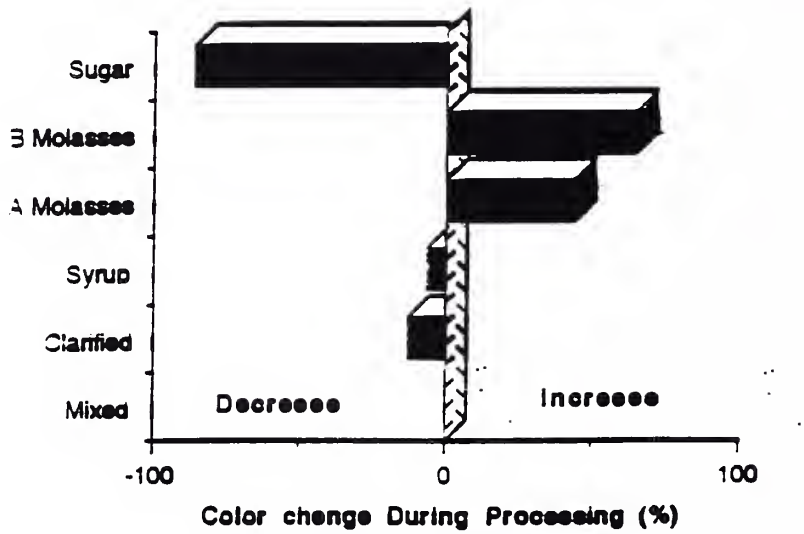

Figure 2. Percentage change in color (ICUMSA units/Brix) with process stage.

A determination was made of the size of the color components present at each process stage. Those compounds which passed through a 5,000 molecular weight ultrafilter are termed high molecular weight (HMW) and those retained by the same filter

are (LMW) low molecular weight. The distribution of color components by size is shown in Figure 3.

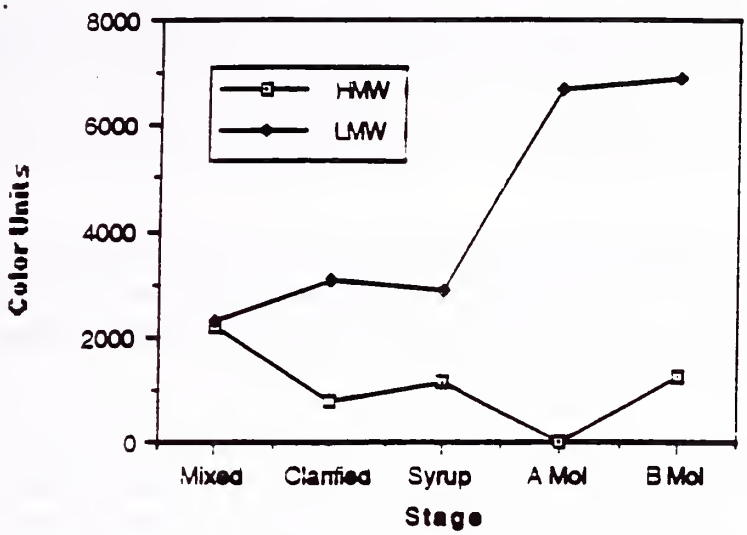

Figure 3. Color due to HMW and LMW components at each process stage

As we expected, the high molecular weight component of color dropped on clarification and then remained essentially constant to the sugar boiling stage of the purification process. This indicated that the conditions in the factory were such that they were not generating significant color during the process. The HMW fraction dropped after the first boiling, perhaps indicating preferential occlusion in the sugar. The LMW fraction increased on processing, with the largest increase being observed during the sugar boiling process.

Overall, most of the color observed in process streams at sugar factories comes in with the cane plant. There is some removal of HMW material with clarification, but it is compensated for by the formation of increased color from low molecular weight color components due to processing. The greatest opportunity for factory management to lower color in the final product will be by improvements in the boiling house. The trend toward increasingly efficient extraction of the sugar in the cane can be expected to extract as well as an increasing amount of plant colorants, such that operators need to be prepared for the possibility of increased color in their sugar.

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International Commission for Uniform Methods of Sugar Analysis. 1994 Method GS1-7.

ISOLATION OF XYLAN FROM A SUGARCANE BAGASSE MOLASSES SAMPLE

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INTRODUCTION AND JUSTIFICATION

A major portion of sugarcane bagasse solids consists of a xylose-rich carbohydrate fraction. This fraction is primarily responsible for the degradable character of bagasse solids in a soil environment. Xylose-rich carbohydrates are easily hydrated, hydrolyzed, and enzymatically depolymerized to monosaccharides.

The isolation of xylose-rich carbohydrates from various biomass sources has been the subject of extensive research by the Biobased Materials Center. Methodology has been established to fractionate biomass from agricultural and forest harvesting resources into constitutive biopolymer fractions, including a xylose-rich carbohydrate, "xylan", in 20-30% yield. Although different methods may be applicable to isolate a xylan component, the best method identified in several years of research involves its extraction in aqueous alkali following pretreatment of the biomass (with dilute HCl and ammonia) as well as delignification (by organosolv pulping or chlorite treatment). Xylans isolated by this stepwise procedure often compose 80% of the total noncellulosic carbohydrates, and they are amorphous and heterogeneous in nature. They typically have 60-75% total pentosans in addition to various minor amounts of hexose, lignin (often 10-20%), and ash.

Other, less complicated and expensive xylan isolation procedures may involve treatment with high pressure steam at various pH levels useful for the generation of an aqueous mixture of monosaccharides, oligosaccharides, and soluble lignin components ("molasses"). Unfortunately, previous experience tells us that these simpler, high pressure steam-based pretreatment procedures are highly degradative to xylans, rendering them degraded to mostly mono- and oligosaccharides. While mild isolation based on the sequential removal of biomass components may yield xylans in high yield (greater than 20%) and with high molecular weight (30 to 50 thousand), more drastic hydrolytic conditions collectively fail to produce a polymeric xylan. It is the assessment of the relationship between pretreatment severity and polymeric xylan yield that has attracted attention to the present study.

OBJECTIVES:

It was the goal of the present study to analyze the xylan content of a molasses fraction generated by proprietary bagasse technology of Audubon Sugar Institute of LSU using standard xylan isolation technology of the Biobased Materials Center.

This part of the LEQSF project was conducted by Virginia Polytechnic Institute through a project under the supervision of Dr. M. Saska.

MATERIALS AND METHODS:

1. Sugarcane molasses (ca. 16 L) was received from LSU on September 23, 1994. The sample was stored in a cold room (4°C) until used. A part of the molasses (1 L) was analyzed on small scale prior to a pilot scale isolation experiment. The pH of the molasses sample was measured at 4.5, and its total solids content (measured by freeze-drying) was determined to be 14.8%.

2. Ultrafiltration (1000 MWCO): A sample of molasses (200 mL) was charged into a 500-mL Erlenmeyer flask. The pH of the solution was adjusted to 7 using 10% NaOH solution. To this mixture, 30% aqueous H_2O_2 (10% on total solids) and tetrasodium ethylenediamine tetraacetate (Na-EDTA, 0.1% w/v) were added. The mixture was heated slowly to 45°C for 2 hours and then allowed to cool for an additional 16 hours. This mixture was subjected to ultrafiltration using an Amicon stirred-cell ultrafiltration unit fitted with a 100 molecular weight cut-off (MWCO) membrane. The mixture was first concentrated to 100 mL before it was diafiltered with an additional 500 mL of water. The ultrafiltered mixture was freeze dried to yield a xylan preparation in 38.7% yield on total solids.

   Ultrafiltration (3000 MWCO): The experiment described in paragraph 2 was repeated using 3000 MWCO membranes. A pilot facility having roughly 10 m^2 filtration area is available to scale-up this experiment at the Biobased Material Center. This ultrafiltration unit also operates with 3000 MWCO spirally wound membrane cartridges (Amicon). This was, however, not employed in this set of experiments since the product had low pentosan content. The yield of the xylan sample was 17.4% of the total solids.

3. Alternate Isolation of Xylan from Sugarcane Bagasse (Control Experiment): Sugarcane bagasse supplied by LSU in the summer of 1993 was also processed using Virginia Tech's most proven xylan isolation technology. This consists of treatment with 0.05 N HCl at 70°C for 2 hours followed by treatment with NH_4OH (pH 9.2) at room temperature for 16 hours. The HCl-ammonia pretreatment bagasse sample was delignified using sodium chlorite and acetic acid at pH 4. A xylan fraction was extracted with 4% NaOH solution at room temperature for 16 hours; this procedure was repeated at 70°C for 2 hours. The combined alkaline extracts were recovered by filtration; they were bleached with H_2O_2 in the presence of Na-EDTA before they were ultrafiltered using a 3000 MWCO membrane. The control xylan was recovered by freeze drying (VT-xylan); it was produced in 22% yield on sugarcane bagasse solids.

RESULTS AND DISCUSSION

Xylan isolation by sequential H_2O_2-bleaching and ultrafiltration yielded a "xylan"-sample from an LSU-generated molasses in 38.7 and 17.4% yield on total solids if ultrafiltered through a 1000 and 3000 MWCO membrane, respectively. The two samples (LSU-xylan, 3000 MWCO and LSU-xylan, 1000 MWCO, Table I) have significantly different composition in terms of xylose and lignin content. These differences suggest that (a) most xylose present in the molasses (starting material) exists in the form of oligosaccharide in the size range between 1000 and 3000

molecular weight; and (b) most lignin exists in molecular weights exceeding 3000 daltons. The LSU-xylan, 3000 MWCO sample proved to consist of carbohydrates, lignin, and ash in almost equal proportions (Table I). Despite the treatment with H_2O_2, the sample remained a dark brown or black powder. The carbohydrate fraction consisted primarily of hexoses (glucose and mannose) and only approximately one-third comprised pentoses. By comparison, a sugarcane bagasse xylan isolated using the more complex and costly isolation of VT proved to yield a "xylan" fraction in 22% yield on bagasse solids, and this preparation consisted of carbohydrates, lignin and ash to the extent of 67.1%, 23.4%, and 9.1%, respectively. The carbohydrate fraction contained only trace amounts of hexose sugars as virtually all were either xylose or arabinose (Table I).

CONCLUSIONS

The isolation of a water-soluble biopolymer from a sugarcane molasses sample supplied by LSU produced a dark brown powder in 17.4% yield of total solids. The carbohydrates of this sample were predominantly hexoses in nature. The appearance resembled more that typical of lignin than that of polysaccharides. It is possible that this preparation represents more a water-soluble condensation product of lignin with pentose-derived furfurals than a typical xylan preparation.

That sugarcane bagasse may yield a high-pentose-containing polysaccharide was demonstrated using the milder and sequential xylan isolation procedure adopted by Virginia Tech. This sample has pale yellow color and it consists of two-thirds carbohydrates, one-fourth lignin, and the remainder ash. The carbohydrates are virtually exclusively xylose and arabinose. The yield of the latter xylan preparation was 22% of the biomass solids and this represents approximately half of all non-cellulosic carbohydrates in bagasse.

ACKNOWLEDGMENT

This is to acknowledge Ms. Jody Jervis for the skillful analysis of bagasse solids.

Table I. Sugarcane Bagasse Xylan Composition

		Molasses (Starting Material)	LSU-xylan[1] 3000 MWCO	LSU-xylan 1000 MWCO	VT-Xylan
I.	Carbohydrate Content (%)				
	Glucose	13.24	13.51	12.06	Trace
	Xylose	21.05	8.24	19.02	63.55
	Galactose	2.91	4.52	2.87	3.55
	Arabinose				
	Mannose	7.67	8.63	5.39	---
	Total	44.87	34.90	39.34	67.10
II.	Lignin Content (%)				
	Klason lignin	8.35	26.3	14.30	17.8
	Acid soluble lignin	8.96	8.4	9.15	5.6
	Total	17.31	34.7	23.45	23.4
III.	Furfurals (%)				
	Furfural	0.90	0.27	0.25	2.53
	HMF	1.00	0.15	0.72	---
IV.	Ash (%)[2]	8.3	30.0	18.7	9.1

[1] LSU-xylan filtered through 3000 MWCO membranes; same treatment at VT-xylan.

[2] Determined by thermogravimetric analysis at 800°C.

CROSS-FLOW FILTRATION WITH CERAMIC AND POLYMERIC MEMBRANES. TREATMENT OF CLARIFIED JUICE WITH CERAMIC ULTRAFILTRATION AND NANOFILTRATION MEMBRANES

Michael Saska
Audubon Sugar Institute

Numerous commercial applications in the food industry (dairy, fruit and vegetable juices, beer, wine, corn sweeteners, gelatin, fermentations, etc.) have proven the advantages of membrane filtration over alternate processes. Invariably they employ the cross-flow (or tangential flow) design that provides, as opposed to deadend filtration (Figure 1), continuous cleaning and higher filtration rates, at the expense of a larger volume of the reject (final retentate) stream . Periodic cleaning with caustic, acid, or a combination of treatments is infrequent and restores in most cases easily the membrane performance. Based on the size (or molecular weight) of the targeted particles, the membranes are conveniently classified (Figure 2) into reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), or microfiltration (MF), although the principles of separation, membrane chemistry, and design are comparable. The favored configurations are spiral-wound and hollow fiber configurations for the polymeric membranes and a tubular, multi-channel design for the ceramic membranes.

The traditional cane juice clarification process (liming) results in only partial clarification, giving a "clarified" juice with substantial residual turbidity (100 - 400 NTU), unsuitable, without further pretreatment, for ion-exchange, or membrane (nanofiltration, reverse osmosis) based separations. UF or MF of clarified juice with ceramic membranes has been shown to be a promising approach to production of low color, low turbidity sugar, reduction of viscosity of low grade massecuites, and improvement in molasses exhaustion, at the same time opening opprtunities for ion-exchange softening of the juice, ion-exclusion based desugarization of molasses, and decolorization of juice syrup with ion-exchange resins or nanofiltration mebranes. (Table 1.)

An example of our extended trials (figures 3 and 4) during the 1994 season, with a Louisiana clarified juice and identical membranes (Rhone-Poulenc/Tech-Sep KERASEP 300,000 MWCO) as those used in the first commercial size system (Hawaiian Commercial and Sugar Company), indicated fluxes on average of the order of 200 l/m2/hr in the VCF (volumetric concentration factor) range 1 to 10. A correlation for the filtration rate F ($L/m^2/Hr$) over a time range to 22 hrs, and VCF from 1 to10,

$$F = A - B \ln(VCF) - C \ln(time)$$

with A = 354, B = 68, and C = 22, was found, albeit with considerable variations from day to day (Figure 4). Because of the large variations of A the average flux did not correlate with the feed juice turbidity, but the sum (B + C), a "fouling index", did correlate fairly well. An average performance over five 20-hour tests is summarized in the following (Table 2.):

Table 1. A partial list of membrane manufacturers, membrane types and their principle current or potential sugar industry-related applications.

COMPANY NAME	U.S. OFFICE	MEMBRANE TYPE	APPLICATIONS
CERAMEM	Waltham, MA	Ceramic, UF/MF	
DESALINATION	Escondido, CA	ORG/SW, RO/NF/UF	RS (P), CJ(P)
DOW/FILMTEC	Midland, MI	ORG/HF; UF/MF	BJ (P), REF(P)
DUPONT/CARRE	Wilmington, DE	Stanless steel	
KOCH	Wilmington, MA	ORG/SW; RO/UF/MF	REF(P)
MEMBRANE PRODUCTS	Charlotte, NC	ORG/SW, RO/UF/MF	
RHONE-POULENC/TECH-SEP	Cranbury, NJ	Ceramic, NF/UF/MF	CJ (C), MOLAS (P), RS (P), REF (P)
U.S.FILTER/MEMBRALOX	Warrendale, PA	Ceramic, UF/MF	BJ(P)

ABBREVIATIONS:

ORG = ORGANIC, POLYMERIC
CJ = CLARIFIED JUICE
BJ = BEET DIFFUSION JUICE
C = COMMERCIAL
RO = REVERSE OSMOSIS
RS = RAW SUGAR
SW = SPIRAL WOUND
NF = NANOFILTRATION
UF = ULTRAFILTRATION
HF = HOLLOW FIBERS
MF = MICROFILTRATION
REF = REFINERY LIQUORS
P = PILOT

Table 2. UF of clarified juice, average performance of five 20 Hr tests, ASI ceramic pilot, KERASEP (19 channel, 300,000 MWCO), batch tests, TMP 3.2 - 4 bars, 90 C, velocity 6.5 m/s.

	FEED	PERMEATE	% CHANGE
BRIX	14.2	14.2	0
TURBIDITY, NTU	240	1	-99.6
COLOR, ICU	11,600	11,400	-1.7
STARCH, ppm/BRIX	560	300	-46
DEXTRAN. ppm/BRIX	620	140	-77

Records from one of the batch 20-Hr tests (Figure 3) show the variations of the (computer) controlled variables (temperature, flow velocity and TMP), permeate flux, and VCF. After the initial pre-programmed ramping of TMP over the first two hours, the controlled variables were kept within narrow limits. The permeate flux declined because of membrane fouling (time effect) and increasing VCF (concentration effect, i.e. increasing colloidal content, viscosity, etc.) from the initial 280 L/m^2/Hr to the final 130 L/m^2/Hr at a very high VCF of 34.

It was found later, in our tests with molasses, that the "history" of the feed may effect the filtration behavior, and may have contributed somewhat to the variations found from one test to another. The summary in Figure 4 contains two types of tests: in one, the clarified juice was brought to ASI, quickly chilled to 10 C with a plate heat exchanger, and ultrafiltered, in a batch mode where the retentate was returned to a small (hot) feeding tank. The main part of the juice was thus kept cold to prevent inversion and color formation. Later in the season the pilot was brought to a factory, where it was supplied with fresh hot clarified juice throughout the duration of the batch tests.

The ultrafiltration and microfiltration of clarified juice is a technically feasible process for production of turbidity-free juice, suitable for production of low color, turbidity free sugar. The expected side benefits, i.e. lower viscosity and lower color formation in the process are still being investigated, as is the economic feasibility of further decolorization of this juice with nanofiltration membranes, and continuous ion-exchange-based decolorization, to produce white or nearly white sugar directly in the cane factories. Pending these investigations, it is still uncertain whether the benefits could potentially outweigh the high capital cost of the ceramic membrane systems, estimated for an average Louisiana factory at $3 million.

ACKNOWLEDGMENTS

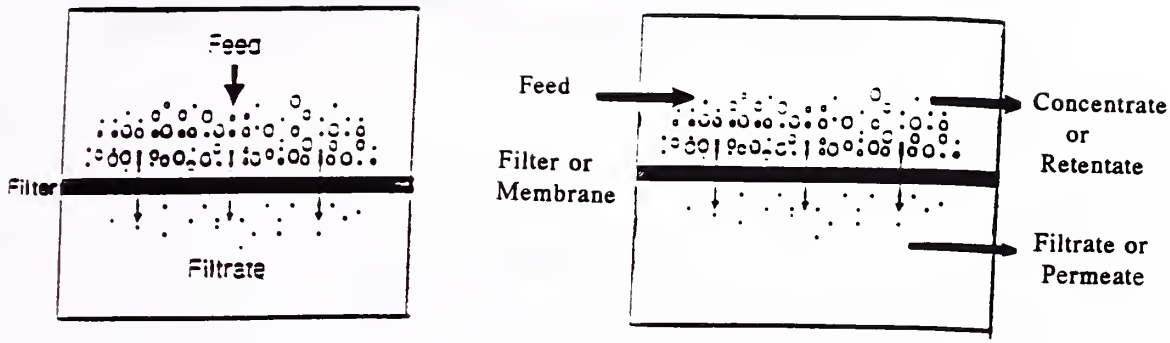
Substantial contribution of Mr. Jean deLataillade (presently with Applexion, Epone, France) and Charles LeRenard, the ASI research personnel associated with the membrane testing program, is gratefully acknowledged, as well as Ms. Mei Di Wu's analytical support. Appreciation is extended to the following organizations that have contributed in the last three years financial support for the author's separation programs: the American Sugarcane League (Thibodaux, Louisiana); the Louisiana Educational Quality Support Fund (LEQSF), the United States Department of Agriculture (USDA) and Applexion (Epone, France).

FIGURE 1: Principles of deadend filtration (left) and tangentional (or cross-flow) filtration. In the cross-floc filtration, concentrate (retentate) is fully (batch tests) or partially recirculated at a high speed along the membrane surface (from Merlo etal, 1993).

FIGURE 2: Classification of membranes based on the their molecular weight cut-off (MWCO). RO = reverse osmosis, NF = nanofiltration, UF = ultrafiltration. MF = microfiltration (from Merlo etal, 1993).

FIGURE 3: A 20 Hr batch test with ultrafiltration of a Louisiana clarified juice (membrane Rhone-Poulenc/KERASEP 300,000 MWCO, 19 channels), ASI ceramic membrane pilot.

FIGURE 4: Summary of a number of 20 Hr batch tests with ultrafiltration of clarified juice (Louisiana, 1994 season). VCF = volume of feed/volume of concentrate. Temperature 90 C, flow velocity 6.5 cm/min, TMP 3.5 to 4 bars.



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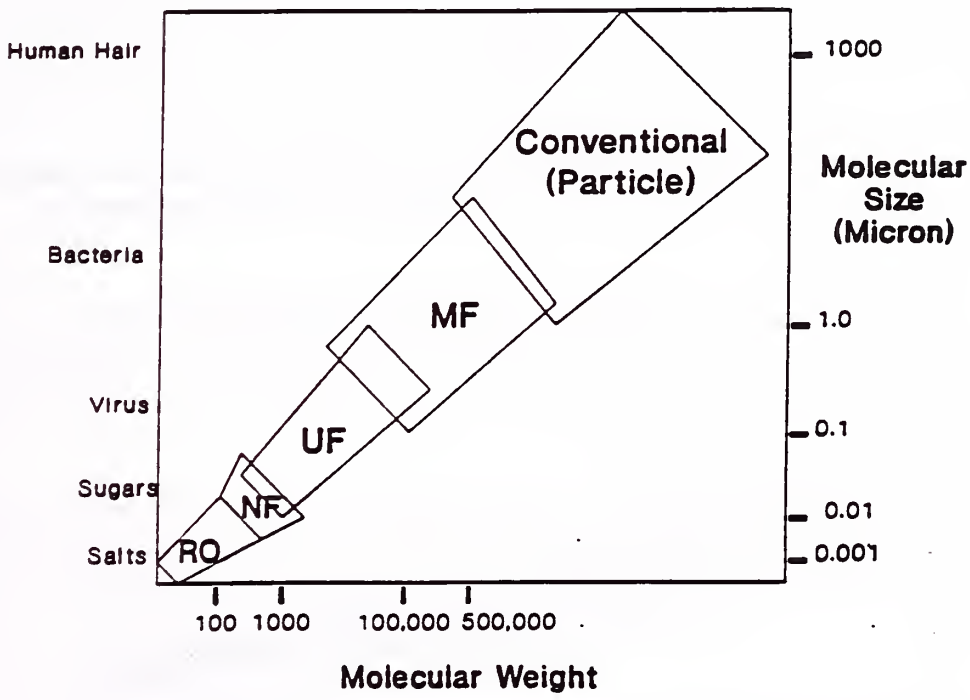

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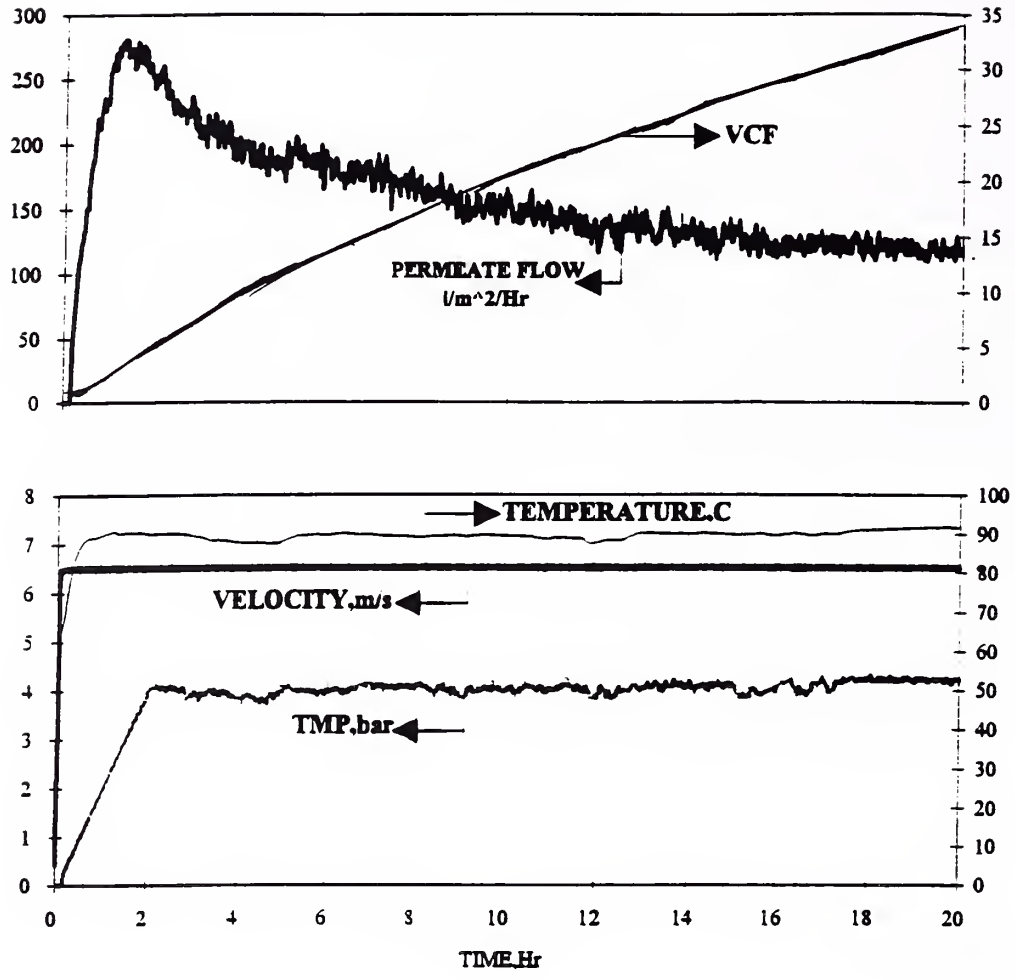

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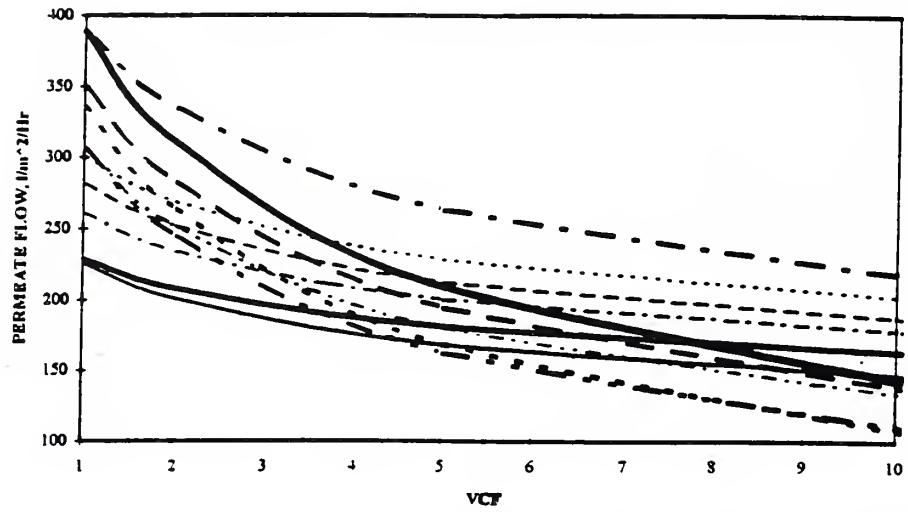

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SUGARCANE RIND PROCESSING INTO GEOTEXTILE

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Chemical Engineering, Human Ecology, and Audubon Sugar Institute

SUMMARY

A process is being developed for conversion of sugarcane rind to textile and geotextile products. It includes partial, directional delignification and agitation and\or tumbling preceding washing and subsequent optional steam explosion steps. The ultimate fibers in sugarcane rind are similar to those of hard wood, 2 to 5 mm long; however, to form geotextile mats or spin yarns, the fiber bundles used should be at least 2.5 cm long. A sugarcane crushing process causes the length of bagasse segments to be too short; therefore, this conversion process starts with a separation similar to that referred to as a "Tilby Process." The cane is split longitudinally in two halves, the high sucrose content pith routed out, and the resulting rind used for this process. The typical treatment for production of geotextile fibers is to react 0.1 N NaOH at 166°C (steam pressure 620 kPa) with the rind segments in a reactor designed to preform specific mechanical actions. The wet and partially delignified fiber bundles can be damaged by complete rotatory action of an impeller in the reactor; therefore, either an oscillating agitation and/or tumbling of the reactor around its horizonal axis is employed. All experimental runs included tumbling and some feature agitation also. Since the rind is encouraged to split longitudinally rather than transversely by the mechanical action, lignin is removed preferentially in the longitudinal direction. As a result bundles of fibers from the rind are successively reduced in cross section with slight reduction in length, thereby yielding the necessary length and desired cross section for conversion to geotextile products.

INTRODUCTION

The experimental process for production of geotextile fibers was fully described in several publications. To avoid repetition of material previously reported (1,2,3), readers are encouraged to refer to the last issue of LAES "SUGARCANE RESEARCH" annual report for 1993.

Geotextile mats formation, turf establishment, and biodegradability are the focus of this report. The sugarcane fiber mats were tested and compared to kenaf, wood fiber, and coconut mats for erosion control and road side turf grass establishment.

GEOTEXTILE MATS FORMATION

The delignified and steam exploded cane fibers were used to form erosion control mats. The fiber length range from 50 to 100 mm and about 1 mm in diameter. For non woven mats, a specified mass of fiber bundles is placed into a 600X600-mm sieve. The sieve was then placed into 900X900X150-mm aluminum pan full with water. The fibers were evenly distributed by floatation and tapping with 600-mm long piece of wood. The sieve was then lifted from the pan. While the water was draining, the wet mat was gently tapped until compacted. The sieve was

then inverted, and the mat was dropped out and left there to dry in the sun. When fully dry, the mats have structural integrity due to fiber entanglement and can be handled without excessive breaking or shearing.

Three different mat thicknesses were used for the turf establishment test. The weights and the corresponding thicknesses were as shown in Table 1. These mats along with kenaf, wood fiber, and coconut fiber mats were field tested at Burden research site. Testing site preparation,

Table 1

Cane Rind Fiber Mats	Type 1	Type 2	Type 3
Number of Mats	4	4	4
Average Weight (gms)	2[illegible]8	248	184
Average Thickness (mm)	12	9	7
Average Planar Density (kg/m^2)	0.77	0.67	0.49

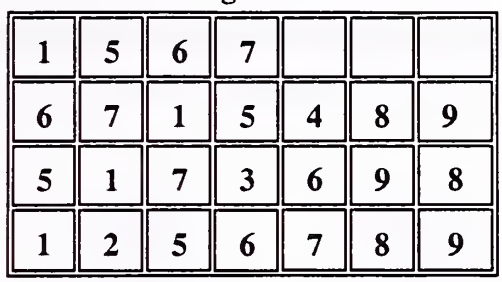
experiment monitoring, and data collection were done by Dr. Dennis Shepard and his graduate student Mark LeBlanc of the LSU Horticulture Department (4). Below is the preliminary study report.

TESTING SITE PREPARATION

The test area was established at Burden Research Plantation, 4560 Essen Lane, Baton Rouge, LA. The existing vegetation on the test site was killed by spraying Roundup three times during June and July of 1994. The area was then rototilled and leveled for seed-bed preparation. The initial PH was 6.4 (ideal for Bermudagrass), and one pound of nitrogen, phosphate, and potash was applied with 13-13-13 fertilizer prior to planting. Bermudagrass was sowed at a rate equivalent to 1.5 lbs/1000 ft^2 on August 4, 1994 and covered with the sugarcane and kenaf mats. On August 25, 1995 Bermudagrass was sowed and covered by mats of wood fiber and coconut fiber. Irrigation was applied as needed to assist germination during the following two weeks.

The testing site was divided into small plots. Each plot was 600X600-mm with 600-mm boarders between any two identical layouts as shown in figure 1. The numbers inside the plots represent mat treatment.

Figure 1



1- Control (Bermudagrass, seeded and protected until germination.)
2- Kenaf - 188 gms (1 rep)
3- Kenaf - 237 gms (1 rep)
4- Kenaf - 290 gms (1 rep)
5- Sugarcane - 184 gms (Avg. weight of 4 reps)
6- Sugarcane - 248 gms (Avg. weight of 4 reps)
7- Sugarcane - 284 gms (Avg. weight of 4 reps)
8- Wood fiber
9- Coconut fiber

Plots were rated for density weekly beginning August 18, 1994 for eight weeks.

RESULTS

The test was designed to measure the rate of growth of the Bermudagrass through the different mats. The rate of growth obtained was visually compared with that of the control plots. Meanwhile, the decomposition and biodegradation of the mats was monitored.

Figures 2, 3, and 4 are graphical representation of the Bermudagrass propagation through the different mats. Figure 2 is comparison of the propagation rate in the plots covered by sugarcane, kenaf, wood, and coconut fiber mats as opposed to the control plot. It shows the percentage of the plot area covered by the bermuda grass through the eight weeks period. Figure 3 is a comparison between the 3 types (each average of 4 replicas) of the sugarcane mats. It shows the growth rate of the Bermudagrass through the different mats thicknesses. Figure 4 is representation of the Bermudagrass propagation through the three types of the kenaf mats.

The following observation can be inferred from figures.

1- There is no statistically significant difference between sugarcane, kenaf, commercial wood, and coconut mats.

2- Sugarcane percent area coverage is apparently greater than other mats.

3- All but the coconut and polyolefin of coconut stitching of coconut mats were biodegraded in less than seven months.

Figure 2 : Bermuda Grass Propogation Through
Sugarcane, Kenaf, Wood, and Coconut Fiber Mats

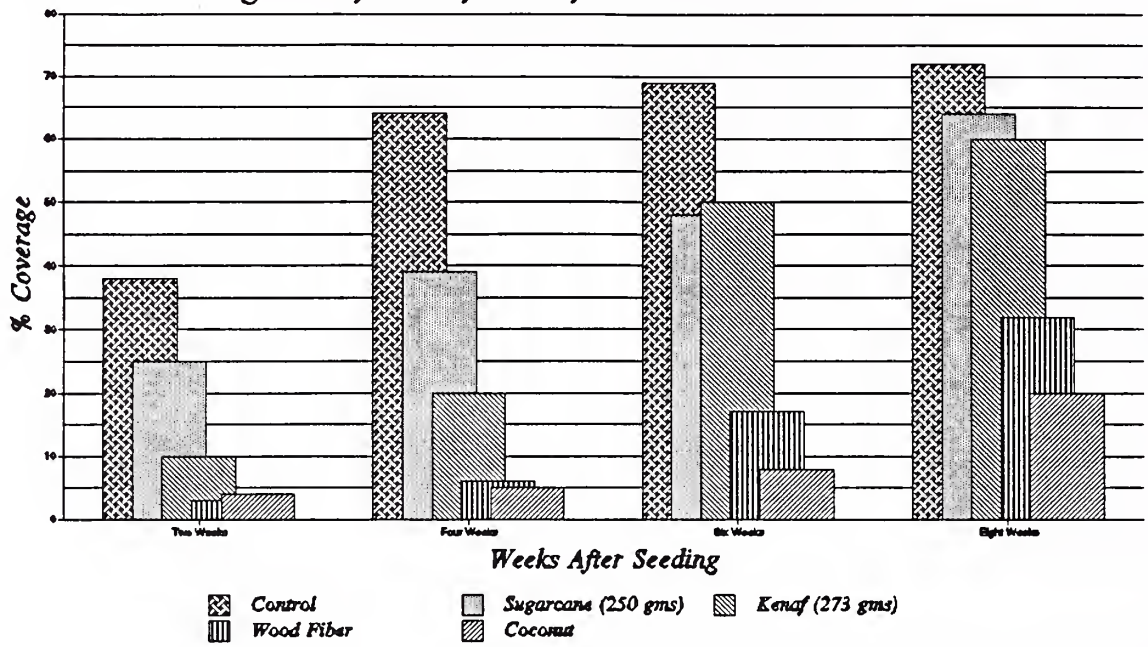


Figure 3 : Bermuda Grass Propogation Through
Sugarcane Fiber Mats

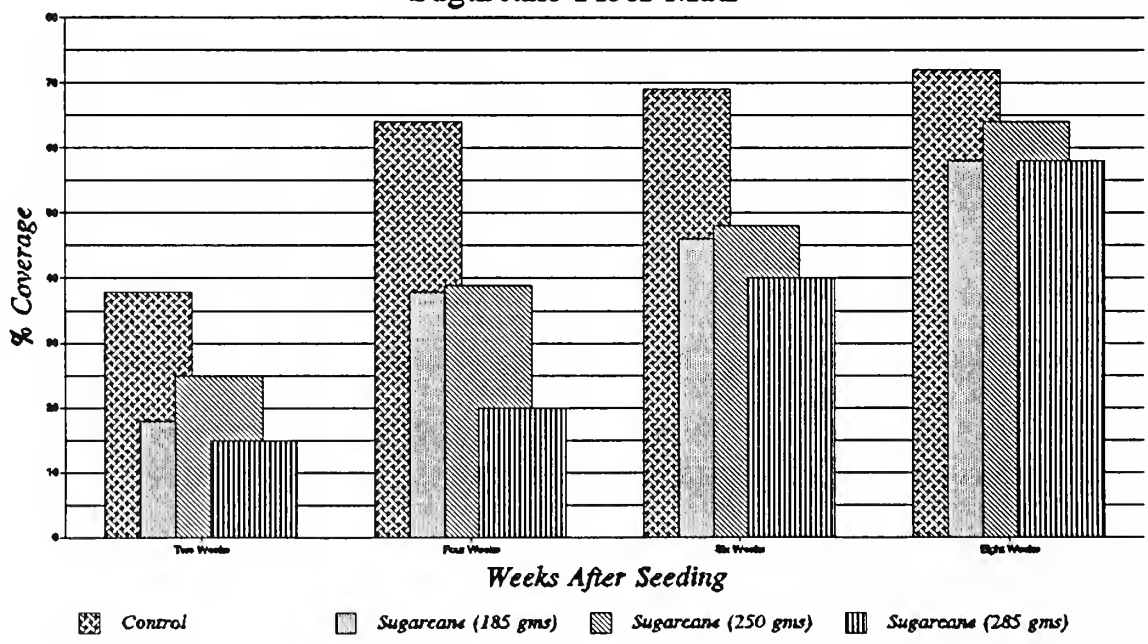
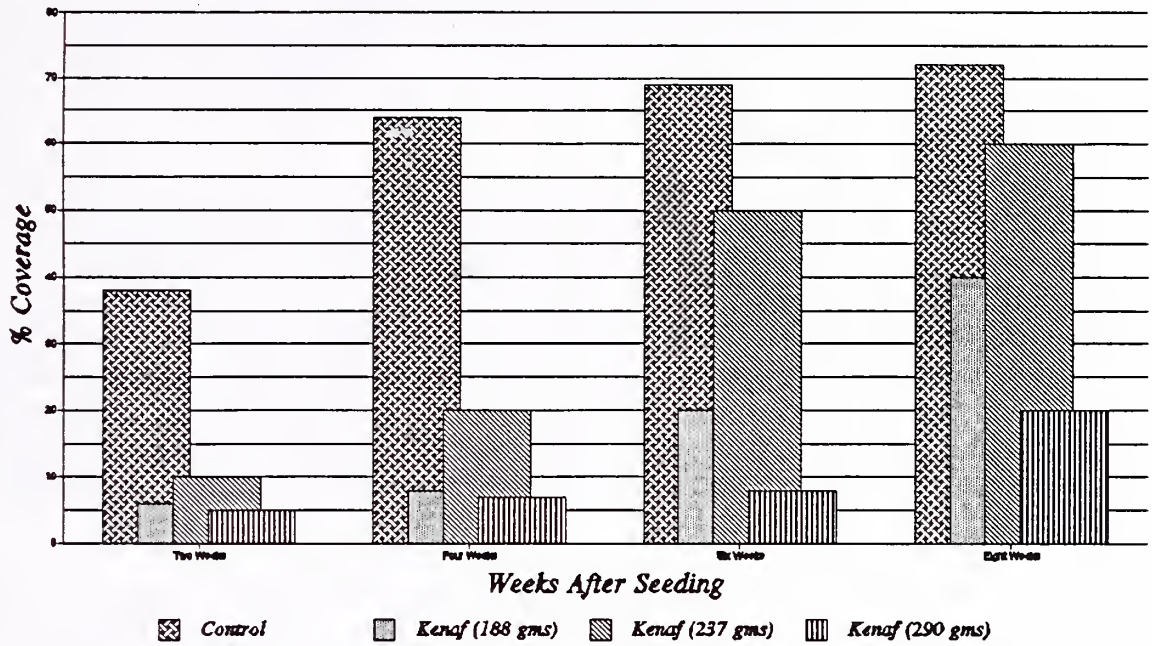


Figure 4 : Bermuda Grass Propogation Through Kenaf Fiber Mats



ACKNOWLEDGEMENT

Financial support for the development of sugarcane process was provided by LEQSF and ASSCT; and continuing support is being provided by USDA, ASCL, and LTRC.

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IMPACT OF LULA WETLAND DISCHARGE ON BAYOU RECEIVING WATER

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INTRODUCTION AND BACKGROUND

A diked natural bottomland hardwood wetland that received wash water from the Lula sugarcane factory was monitored for Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), pH, and Dissolved Oxygen (DO) for periods of 3 to 6 months from the beginning of the 1991, 1993, and 1994 grinding seasons in October. More than 95% of the incoming BOD and suspended solids was removed from the wetland water by the end of each grinding season in December, and more was removed before discharge from the wetland started. Wetland water pH stabilized quickly during the grinding season to about 7. The dissolved oxygen concentration in the wetland water was low during the grinding season, and it remained low during the monitoring period.

Regulatory agencies have a need to know the impact on receiving waters of effluent discharge from wetlands which are incorporated into wastewater treatment systems. The Louisiana Department of Environmental Quality (LADEQ) sets the standards for the quality for effluent discharges from sugar factories to the state's public waters. LADEQ has set the following standards: the five-day BOD, BOD_5, shall be less than 15 mg/L, TSS shall be less than 50 mg/L, DO shall average no less than 4 mg/L with no reading below 3 mg/L, and pH shall be between 6 to 9.

This investigation has focused on the impact of wetland discharge with or without post-reaeration on the bayou's receiving waters.

IMPACT OF WETLAND DISCHARGE ON RECEIVING BAYOU WATER

The water quality of the sugarcane factory wastewater impounded in the wetlands, as measured by BOD, TSS, and pH, could meet the LADEQ discharge standards about two months after the grinding season started. However, the DO in the impounded wetland water remained below the discharge standards, as shown in Table 1. Thus, no intervention is required to alter the BOD, TSS and pH of the wetland water. However, reaeration of wetland water is required to meet the DO standard.

Stabilization of BOD of the wastewater in the wetlands consumes a large mass of dissolved oxygen. Oxygen is supplied to the water under natural conditions from three sources: atmospheric reaeration, which is enhanced by wind mixing; oxygen, which is released by algal activity (photosynthesis); and oxygen, which is transferred by wetlands' vegetation in root hairs. Atmospheric reaeration is the most important oxygen source. Typically, the dissolved oxygen initially present in the wetlands at the start of the grinding season is used quickly by microbial

Table 1. Quality of Impounded Wetland Water

	LADEQ Std.	Nov.22,1991 (* 44)	Dec.1,1993 (* 56)	Dec.7,1994 (* 51)
BOD_5 (mg/L)	max. < 15	8.6	5.6	7.2
TSS (mg/L)	< 50	24.0	4.7	6.3
pH	6 - 9	7.47	7.70	6.75
DO (mg/L)	> 4	3.05	0.90	0.50

* The number of days after the grinding season starts.

reactions which consume BOD. Then the dissolved oxygen concentration remains near zero during the grinding season. After the grinding season ends, the dissolved oxygen fluctuates about a mean value of 1 mg/L during the monitoring period. Obviously, this low dissolved oxygen concentration is due to its continued consumption while stabilizing the BOD of wastewater and by the benthic sediment's oxygen demand. Part of the dissolved oxygen fluctuations resulted from varying temperature and rainfall. A cold rain, which would be saturated with dissolved oxygen, would increase the dissolved oxygen concentration in the wetlands temporarily while colder temperatures would slow down dissolved oxygen consuming reaction rates. By contrast, warmer temperatures would increase the reaction rate and speed up the dissolved oxygen consuming reaction rates.

Samples were taken after the 1992 grinding season while the impounded water was being discharged from the wetlands to the bayou. Sample collection locations are keyed to the discharge outlets from the wetlands to the bayou. Point 1 is the most upstream point, and point 5 is the most downstream point. At each discharge location DO readings were taken in bayou water upstream and downstream from outlets, as well as at the outlet in the wetland discharge. Figures 1 and 2 show the effect of discharges from wetland outlet 3 on the DO and BOD in the bayou water upstream and downstream from the outlet on April 7 and April 28, 1993, respectively.

Figures 1 and 2 show that the DO in the bayou water was not always above 4 mg/L. Introduction into the bayou of water low in dissolved oxygen reduced the DO concentration in the receiving bayou water. The resulting downstream DO dropped below 4 mg/L in the bayou.

When the samples were taken BOD_5 values were below 5 mg/L at all points in the wetland except at point 3 . At point 3, figures 1 and 2 show the BOD_5 had an average of 12 mg/L. Discharged wetland waters were higher in BOD than the receiving bayou waters on the April 7 and April 28, 1993 sampling dates.

The water quality values of BOD, TSS, and pH in wetlands near outlet 5 had been identified in previous monitoring as values that would meet the LADEQ discharge standards by the middle of November. Thus, if the DO of the impounded water could be raised to a reasonable level, the wastewater could be discharged into the adjacent bayou by the middle of November. An added advantage of early discharge of wetland water is that lowering the water

level in the wetland avoids prolonged flooding so the bottomland hardwoods in the wetland ecosystem remain healthy.

AERATION TO IMPROVE WETLAND DISCHARGE QUALITY

An aeration station was constructed on a site in the wetland near outlet 5. It began continuous operation two weeks after the 1994 grinding season started. The aeration station has a pump with a flowrate of 25 GPM and a set of nozzle-type aerators. The intake of the pump is located in the wetlands. The aerated effluent from the aerator unit discharges into a nearby bayou.

When the aeration station was run at point 5 of the wetland during the 1994 grinding season, samples were taken from the bayou 500 feet upstream and 500 feet downstream from the wetland discharge site, as well as from the aerator effluent. Figures 3 and 4 show the results of sampling on Nov. 23, 1994 and Dec. 7, 1994, respectively. The wetland water leaving the aerator is nearly saturated with DO and it exceeds the LADEQ standard of 4 mg/L. In addition, the addition of aerated wetland effluent increased the downstream DO in the bayou, although it remained relatively low. The downstream BOD did not show clearly the effects of mixing bayou water and aerated wetland water. However, it is important to note the downstream BOD in the bayou water remained lower than 15 mg/L.

CONCLUSIONS

This diked bottomland hardwood wetland system is very effective for stabilizing the pH and removing BOD and TSS from the sugar factory wastewater. Monitoring shows the water quality near many wetland outlets can meet the LADEQ discharge standards in terms of BOD, TSS and pH in early December. The wetland is not efficient in increasing the DO level to the LADEQ discharge standard. The prolonged period of low DO in the wetland water is caused by the stabilization of BOD, benthic demand for oxygen by sediments, and low reaeration rates.

The application of post-reaeration at a wetland outlet was successful in providing an engineering solution to improve the wetland effluent quality to meet LADEQ discharge standards. It enabled wetland water to be discharged to the bayou early during the grinding season as soon as BOD, pH, and TSS met the discharge standards. With the aerator working, discharge from the wetland can start as early as one and one-half months after the grinding season started. By aerating the wetland discharge, adverse impacts of prolonged water impoundment in the wetlands on the wetland ecosystem are avoided. An additional benefit of lowering the water level in the wetland is that the possibility of damaging the dikes by erosion is decreased.

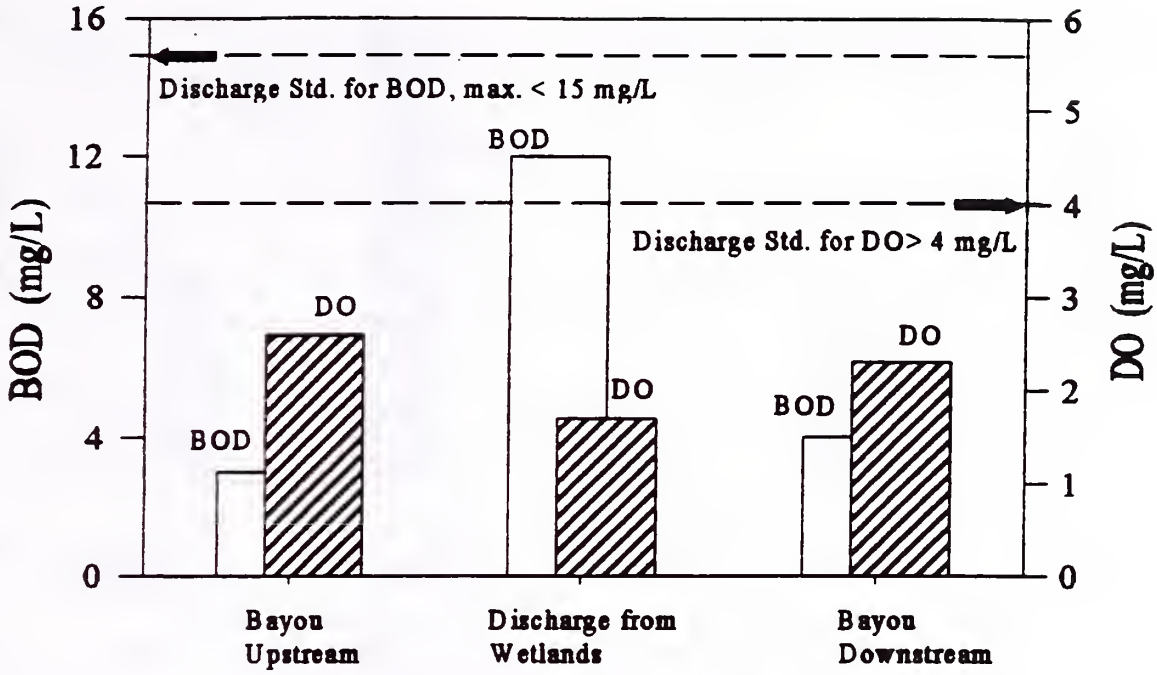

Figure 1. Water quality of bayou upstream from wetland discharge location, water quality in wetland discharge at outlet #3, and water quality in bayou downstream of discharge from outlet #3 on April 7, 1993.

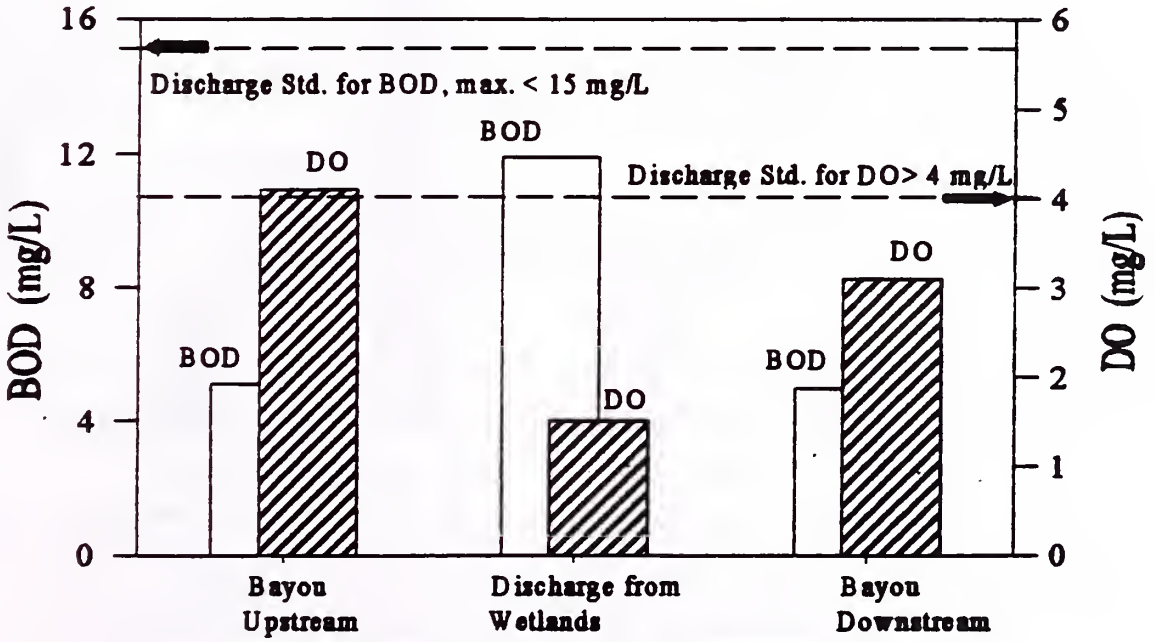

Figure 2. Water quality of bayou upstream from wetland discharge location, water quality in wetland discharge at outlet #3, and water quality in bayou downstream of discharge from outlet #3 on April 28, 1993.

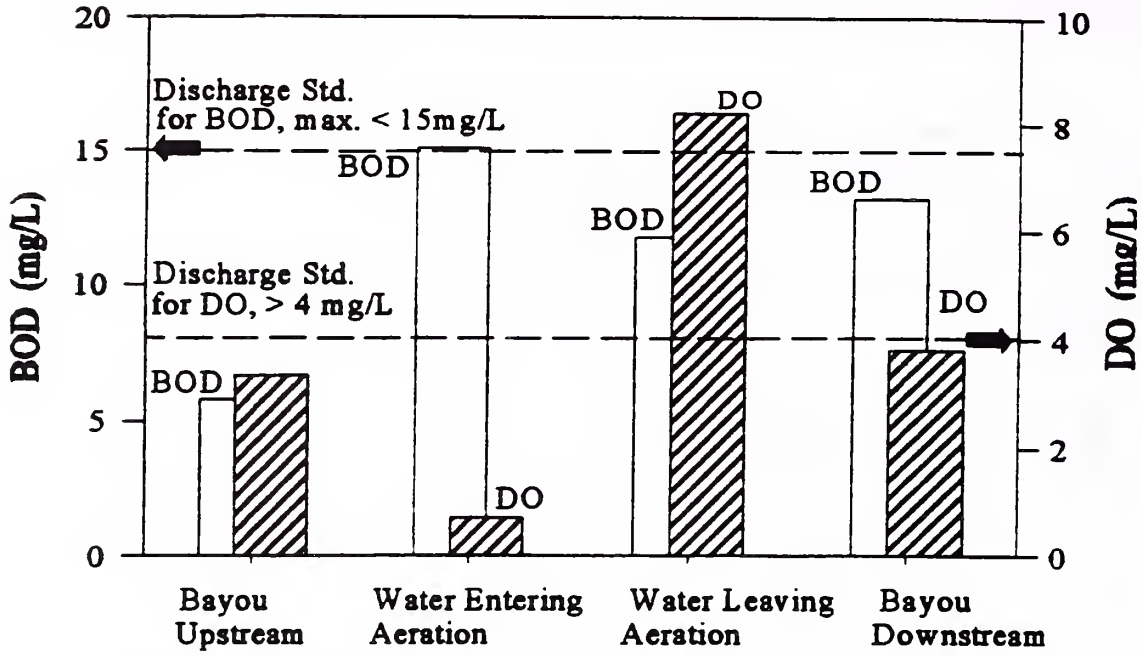

Figure 3. Water quality of bayou upstream from wetland discharge location, wetland water quality entering and leaving aerator, and water quality of bayou downstream of wetland discharge from outlet #5 on November 23, 1994.

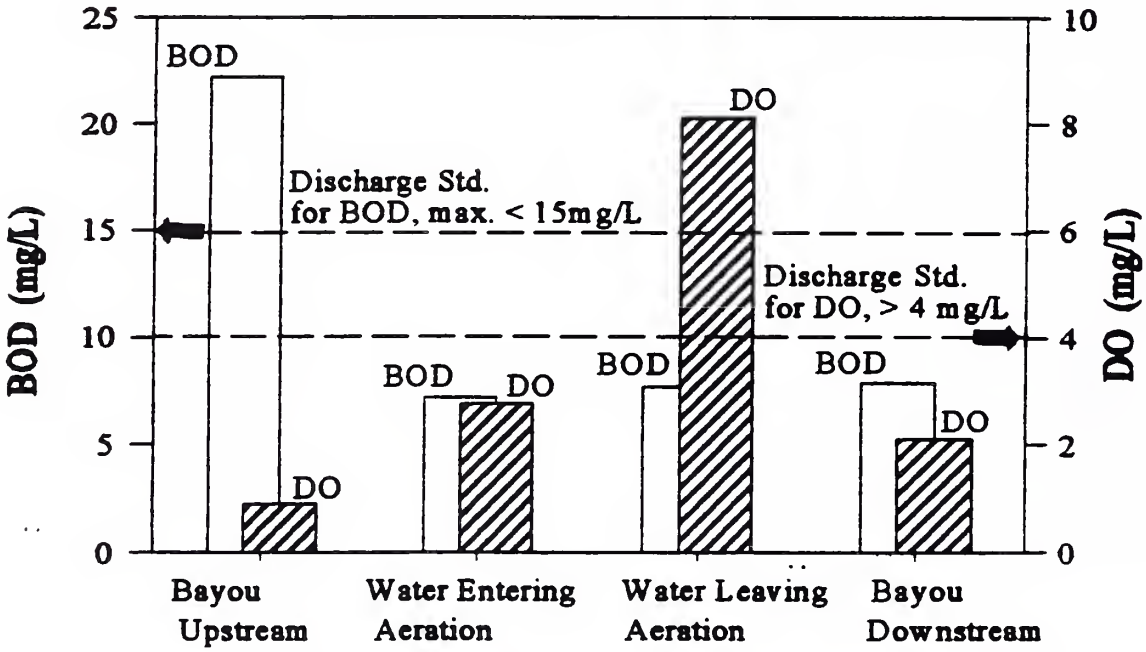

Figure 4. Water quality of bayou upstream from wetland discharge location, wetland water quality entering and leaving aerator, and water quality of bayou downstream of wetland discharge from outlet #5 on December 7, 1994.

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